9.0 SOURCE TEST PROCEDURES

9.1 INTRODUCTION

A number of methods exist to determine mercury (Hg) emissions from stationary sources. Several EPA offices and some State agencies have developed source specific or dedicated sampling methods for Hg. Other industry sampling methods exist, including continuous emission monitors (CEMs), but these methods have not been validated and are not discussed in this section.

Subsequent parts of this section discuss EPA reference or equivalent sampling methods for Hg. Sampling methods fall into one of two categories: (1) dedicated Hg methods for specific sources or (2) multiple metals sampling trains that include Hg for multiple sources. Each category of methods is described, differences among the methods are discussed, and a citation is provided for more detailed information about the methods. A summary of methods is presented in Table 9-1.

Sampling methods included in this section were selected from EPA reference methods and State methods. To be a reference method, a sampling method must undergo a validation process and be published. To qualify as an equivalent method, a sampling method must be demonstrated to the EPA Administrator, under specific conditions, as an acceptable alternative to the normally used reference methods.

9.2 DEDICATED MERCURY SAMPLING METHODS

9.2.1 EPA Method 101-Determination of Particulate and Gaseous Mercury Emissions from Chlor-Alkali Plants (40 CFR, Part 61, 1992)

This method can be used to determine particulate and gaseous Hg emissions from chlor-alkali plants and other sources (as specified in the regulations) where the carrier-gas stream in the duct or stack is principally air.[151] Particulate and gaseous Hg emissions are withdrawn isokinetically from the source and collected in an acidic iodine monochloride (ICl) solution. The Hg collected (in the mercuric form) is reduced to elemental Hg and then aerated and precipitated from the solution into an optical cell and measured by atomic absorption spectrophotometry (AAS). A diagram of a sampling train typical of dedicated Hg sampling trains is presented in Figure 9-1.

After initial dilution, the range of this method is 0.5 to 120 micrograms of Hg per milliliter (μg Hg/ml). The upper limit can be extended by further dilution of the sample. The sensitivity of this method depends on the selected recorder/spectrophotometer combination.

Analytical interferences include SO_2, which reduces ICl and causes premature depletion of the ICl solution. Also, concentrations of ICl greater than 10^{-4} molar inhibit the reduction of the Hg(II) ion in the aeration cell. Condensation of water vapor on the optical cell windows of the AAS causes a positive interference.

Estimates of precision and accuracy were based on collaborative tests, wherein 13 laboratories performed duplicate analyses on two Hg-containing samples from a chlor-alkali plant and on one laboratory-prepared sample of known Hg concentration. The estimated within-laboratory and between-laboratory standard deviations are 1.6 and 1.8 μg Hg/ml, respectively.

TABLE 9-1. MERCURY SAMPLING METHODS

Method	Filter	Impinger	Range	Chemical interference	Detection limit
EPA 101	None	3 X ICl 1 X silica gel	0.5 to 120 µg Hg/ml	SO_2	Not listed
EPA 101A	Glass fiber (optional)	1 X $KMnO_4$ 2 X $KMnO_4$ 1 X silica gel	20-800 ng Hg/ml	Oxidizable organic matter, Water vapor on optical window	Not listed
EPA 102	None	3 X ICl 1 X silica gel	0.5 to 120 µg Hg/ml	SO_2	Not listed
EPA 29	Quartz or glass fiber	1 X empty (optional) 2 X HNO_3/H_2O_2 1 X empty 2 X $KMnO_4/H_2SO_4$ 1 X silica gel	ngHg/ml to µg Hg/ml	None	0.2 ng Hg/ml
SW-846 0012	Quartz or glass fiber	1 X empty (optional) 2 X HNO_3/H_2O_2 1 X empty 2 X $KMnO_4/H_2SO_4$ 1 X silica gel	ngHg/ml to µg Hg/ml	None	0.2 ng Hg/ml
OSW-BIF	Quartz or glass fiber	1 X empty 2 X HNO_3/H_2O_2 1 X empty 2 X $KMnO_4/H_2SO_4$ 1 X silica gel	ngHg/ml to µg Hg/ml	None	0.2 ng Hg/ml
CARB 436	Quartz or glass fiber	1 X empty 2 X HNO_3/H_2O_2 2 X $KMnO_4/H_2SO_4$ 1 X silica gel	ngHg/ml to µg Hg/ml	None	0.2 ng Hg/ml

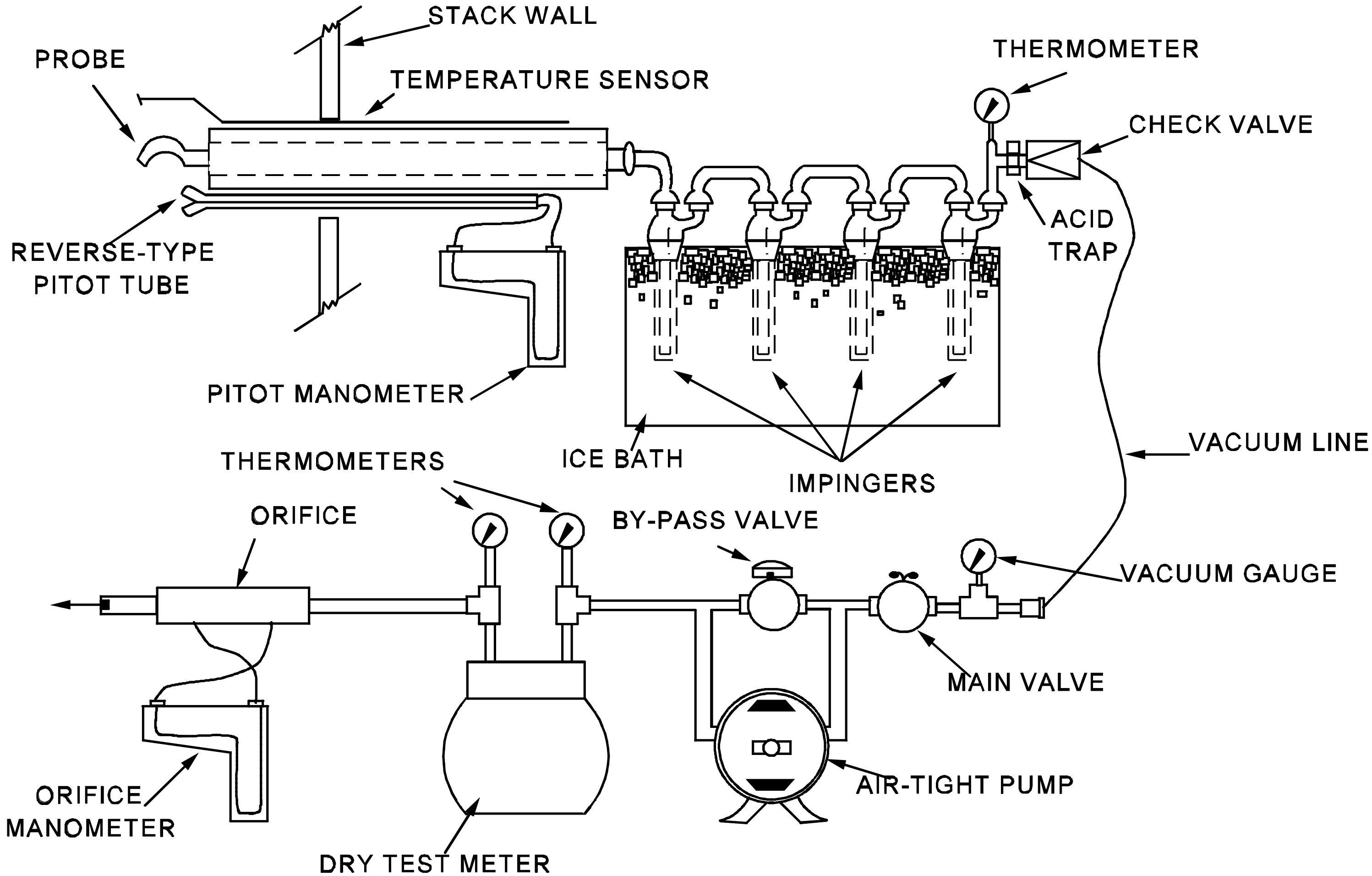

Figure 9-1. Typical dedicated mercury sampling train.

9.2.2 EPA Method 101A-Determination of Particulate and Gaseous Mercury Emissions from Stationary Sources (40 CFR, Part 61, 1996)

This method is similar to Method 101, except acidic potassium permanganate ($KMnO_4$) solution is used for collection instead of acidic ICl.[152] This method is used to determine particulate and gaseous Hg emissions from stationary sources. This method is a revised version of EPA Method 101 as published in 40 CFR, Part 61, 1992, which was entitled "Determination of Particulate and Gaseous Mercury Emissions from Sewage Sludge Incinerators."

Particulate and gaseous Hg emissions are withdrawn isokinetically from the source and collected in acidic $KMnO_4$ solution. The Hg collected (in the mercuric form) is reduced to elemental Hg, which is then aerated from the solution into an optical cell and measured by AAS or by any atomic absorption unit with an open sample presentation area in which to mount the optical cell.

After initial dilution, the range of this method is 20 to 800 nanograms of Hg per milliliter (ng Hg/ml). The upper limit can be extended by further dilution of the sample. The sensitivity of the method depends on the selected recorder/spectrophotometer combination.

Analytical interferences include excessive oxidizable organic matter in the stack gas, which prematurely depletes the $KMnO_4$ solution and thereby prevents further collection of Hg. Condensation of water vapor on the optical cell windows of the AAS causes a positive interference.

Based on eight paired-train tests, the within-laboratory standard deviation was estimated to be 4.8 μg Hg/ml in the concentration range of 50 to 130 micrograms of Hg per cubic meter (μg Hg/m^3).

9.2.3 EPA Method 102-Determination of Particulate and Gaseous Mercury Emissions from Chlor-Alkali Plants-Hydrogen Streams (40 CFR, Part 61, 1992)

Although similar to Method 101, Method 102 requires changes to accommodate extracting the sample from a hydrogen stream.[153] Sampling is conducted according to Method 101, except for the following procedures:

1. Operate only the vacuum pump during the test. The other electrical equipment, e.g., heaters, fans, and timers, normally are not essential to the success of a hydrogen stream test.

2. Calibrate the orifice meter at flow conditions that simulate the conditions at the source as described in APTD-0576 (see Citation 9 in Section 10 of Method 101). Calibration should either be done with hydrogen or some other gas having a similar Reynolds Number so that there is a similarity between the Reynolds Numbers during calibration and sampling.

9.3 MULTIPLE METALS SAMPLING TRAINS

9.3.1 Method 0012-Methodology for the Determination of Metals Emissions in Exhaust Gases from Hazardous Waste Incineration and Similar Combustion Sources

Method 0012 was developed for the determination of 16 metals, including Hg, from stack emissions of hazardous waste incinerators and similar combustion processes.[154] While Method 0012 can be used to determine particulate emissions from these sources, the filter heating/desiccation modifications to the sample recovery and analysis procedures for determining particulate emissions may potentially impact the front-half Hg determination. A diagram of a sampling train typical of a multiple metals sampling train is presented in Figure 9-2.

The stack sample is withdrawn isokinetically from the source. Particulate emissions are collected in the probe and on a heated filter; gaseous emissions are collected in a series of moisture knockout traps, chilled impingers, and silica gel traps. Of the four solution charged impingers, two contain an aqueous solution of dilute nitric acid (HNO_3) combined with dilute hydrogen peroxide (H_2O_2) and two contain acidic potassium permanganate ($KMnO_4$) solution. Materials collected in the sampling train are digested with acid solutions using conventional Parr® Bomb, or microwave digestion techniques to dissolve

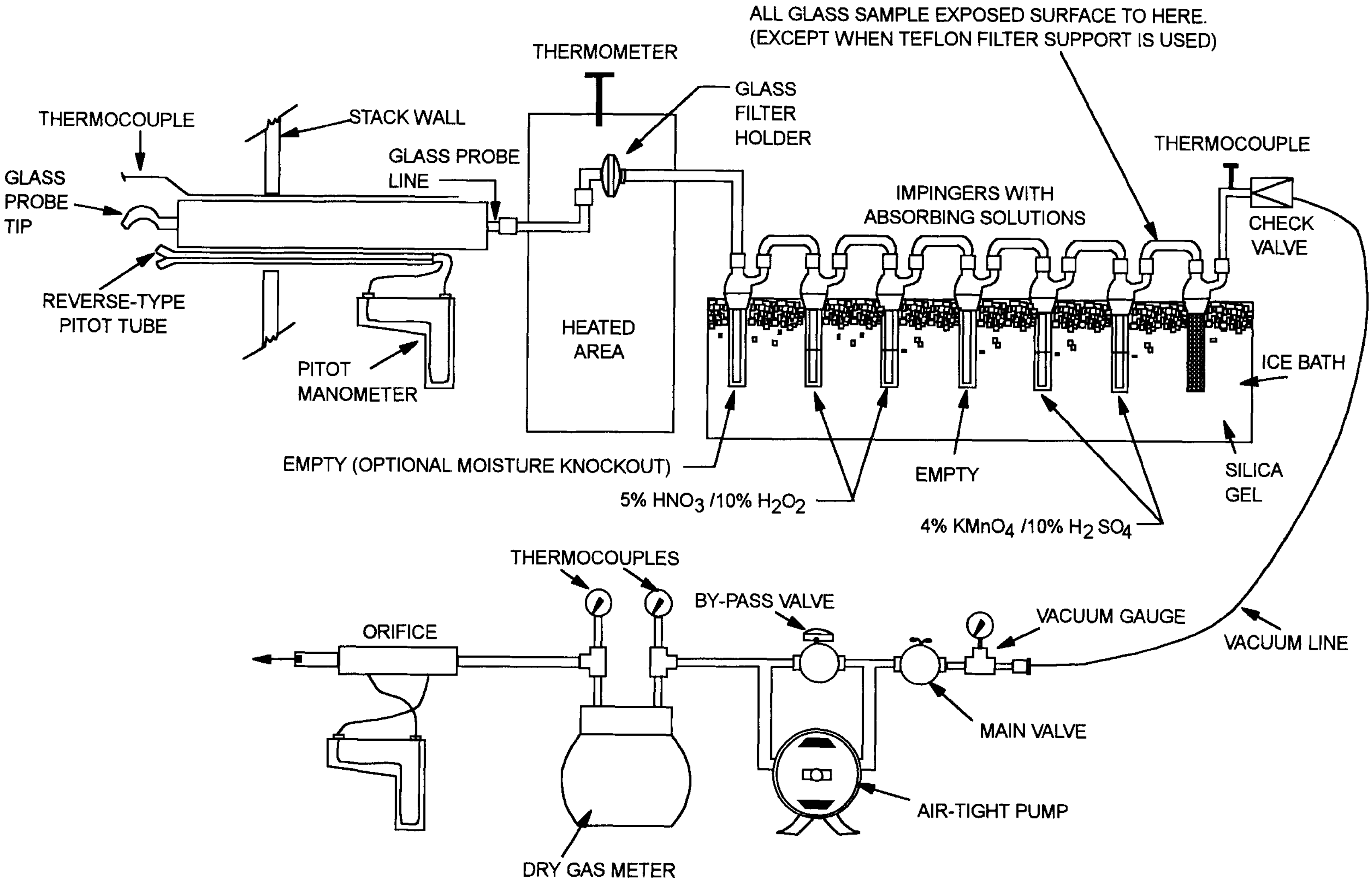

Figure 9-2. Typical multiple metals sampling train.[154]

inorganics and to remove organic constituents that may create analytical interferences. As many as six separate samples can be recovered from the sampling train. The HNO_3/H_2O_2 impinger solution, the acidic $KMnO_4$ impinger solution, the hydrochloric acid (HCl) rinse solution, the acid probe rinse, the acetone probe rinse, and digested filter solutions can be analyzed for Hg by cold vapor atomic absorption spectroscopy (CVAAS). As few as three sample fractions can be analyzed for Hg: the combined probe rinse and filter, the combined HNO_3/H_2O_2 impinger solutions, and the combined $KMnO_4$ impinger and rinse solutions. The detection limit for Hg by CVAAS is approximately 0.2 ng Hg/ml.

The corresponding in-stack method detection limit can be calculated by using (1) the procedures described in this method, (2) the analytical detection limits described in the previous paragraph, (3) a volume of 300 ml for the front-half and 150 ml for the back-half samples, and (4) a stack gas sample volume of 1.25 m^3:

$$\frac{AxB}{C}=D$$

where: A = analytical detection limit, μg Hg/ml
B = volume of sample prior to aliquot for analysis, ml
C = sample volume, dry standard cubic meter (dscm)
D = in-stack detection limit, μg Hg/m^3

The in-stack method detection limit for Hg using CVAAS based on this equation is 0.07 μg Hg/m^3 for the total sampling train. A similar determination using AAS is 5.6 μg Hg/m^3.

Two other multiple metals sampling methods developed by EPA can be used to collect Hg. These methods are the Methodology for the Determination of Metals Emissions in Exhaust Gases from Hazardous Waste Incineration and Similar Combustion Sources and EPA Method 29-Methodology for the Determination of Metals Emissions from Stationary Sources.[155,156] Both methods are virtually identical to Method 0012 in sampling approach and analytical requirements.

9.3.2 CARB Method 436-Determination of Multiple Metals Emissions from Stationary Sources

This method can be used to determine the emissions of metals, including Hg, from stationary sources.[157] This method is similar to SW-846 Method 0012 in sampling approach and analytical requirements. Method 436 suggests that the concentrations of target metals in the analytical solutions be at least 10 times the analytical detection limits. This method may be used in lieu of Air Resource Board Methods 12, 101, 104, 423, 424, and 433.

9.4 ANALYTICAL METHODS FOR DETERMINATION OF MERCURY[158,159]

This section contains brief descriptions of two analytical techniques generally used for Hg determinations.

The two Hg analysis methods are Method 7470 and 7471, from SW-846.[158,159] Both methods are cold-vapor atomic absorption methods, based on the absorption of radiation at the 253.7-nm wavelength by mercury vapor. Mercury in the sample is reduced to the elemental state and aerated from solution in a closed system. The Hg vapor passes through a cell positioned in the light path of an atomic absorption spectrophotometer. Absorbance (peak height) is measured as a function of mercury concentration. Cold-Vapor AA (CVAA) uses a chemical reduction to selectively reduce Hg. The procedure is extremely sensitive but is subject to interferences from some volatile organics, chlorine, and sulfur compounds. The typical detection limit for these methods is 0.0002 mg/L.

The two methods differ in that Method 7470 is approved for analysis of Hg in mobility-procedure extracts, aqueous wastes, and ground waters.[158] Method 7471 is approved for analysis of Hg in soils, sediments, bottom deposits, and sludge-type materials.[159] Analysis of samples containing high amounts of organics presents special problems: (1) the tendency to foam during the reduction step, which blocks the flow of sample to the absorption cell and (2) the reduction of Hg(II) to Hg before addition of stannous chloride ($SnCl_2$).

Two analytical considerations are common to both methods. First, stannous chloride should be added immediately prior to analysis to ensure the reduction of Hg(II) to Hg occurs in the vaporization cell only. Second, moisture in the absorption cell can reduce the reliability of the method and should be eliminated or minimized. Finally, a closed-loop system may provide a more reliable system than an open-loop system for introducing the sample to the reaction flask.

9.5 SUMMARY

All of the above source sampling methods collect a sample for analysis of multiple metals, including Hg, or a sample for Hg analysis alone. Significant criteria and characteristics of each method are presented in Table 9-1. This table is a summary of information presented in various methods. The major differences among the methods involve (1) the type of impinger solutions, (2) the amount or concentration of impinger solutions, (3) the sequence and types of sample train recovery solutions, and (4) the use and/or type of particulate filter.

In assessing Hg emissions from test reports, the age or revision number of the method indicates the level of precision and accuracy of the method. Older methods are sometimes less precise or accurate than those that have undergone more extensive validation. Currently, EPA Method 301 from 40 CFR Part 63, Appendix A, can be used to validate or prove the equivalency of new methods.

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APPENDIX A

NATIONWIDE EMISSION ESTIMATES

SECTION 4

EMISSIONS FROM MERCURY PRODUCTION

Primary Mercury Production --

Mercury is no longer mined as a primary product in the United States.

Secondary Mercury Production --

Basis of Input Data

1. In the 1994 TRI summary, mercury emissions were reported for 2 of the 3 major secondary mercury producers. Mercury Refining Company reported emissions of 116 kg (255 lb) and Bethlehem Apparatus Company reported emissions of 9 kg (20 lb). The third major company, D.F. Goldsmith, does not reclaim mercury from scrap materials using extractive processes.

2. Emissions from secondary mercury production are uncontrolled.

Calculation

Total 1994 emissions = 116 kg + 9 kg = 125 kg = 0.125 Mg = 0.13 Mg = 0.14 tons

Mercury Compounds Production --

No emission factors are available for mercury emissions from this process.

SECTION 5

EMISSIONS FROM MAJOR USES OF MERCURY

Chlorine Production --

Basis of Input Data

1. Table 5-1 presents two sets of mercury emissions data for mercury-cell chlor-alkali facilities. The 1991 data are based on Section 114 information collection requests. The 1994 data are based on voluntary reporting in TRI. Because the totals for the two data sets are essentially the same (12,902 lb vs. 12,438 lb, a difference of less than 4 percent), the TRI data set was used to calculate emissions because these data represent more recent emission estimates.

2. In the 1994 TRI summary, mercury emissions were reported for 12 of the 14 U.S. mercury cell facilities.[3] Mercury emissions for those 12 facilities totaled 12,438 lb.

3. Mercury-cell capacity of the 12 facilities reporting mercury emissions totaled 1,750,000 tons of chlorine.

4. The total number of U.S. chlor-alkali facilities is 14.

5. Total mercury-cell capacity of all 14 U.S. chlor-alkali facilities is 1,998,000 tons of chlorine.[4] SRI figures were adjusted based on Section 114 information collection request responses.

6. Emission data were prorated for the remaining two facilities.

Calculation

Total 1994 emissions for all 14 chlor-alkali facilities =

$$= 12{,}438 \text{ lb} \times \frac{1{,}998{,}000}{1{,}750{,}000}$$

$$= 12{,}438 \text{ lb} \times 1.14$$

$$= 14{,}201 \text{ lb}$$

$$= 7.1 \text{ tons} \quad \text{or} \quad 6.5 \text{ Mg}$$

Battery Manufacture --

Basis of Input Data

1. The 1995 consumption of mercury in the production of primary batteries was less than 0.5 Mg (<0.6 tons).[2]

2. A mercury emission factor of 1.0 kg/Mg used (2.0 lb/ton) was obtained from a Wisconsin study of a mercury oxide battery plant, which is the only type of battery using mercury.[5]

3. The plant used to develop this emission factor discontinued production of this type of battery in 1986. This emission factor may be representative of an outdated production process.

Calculation

Total 1995 emissions = 1.0 kg/Mg x 0.5 Mg = 0.5 kg
0.5 kg = 5 x 10^{-4} Mg = 6 x 10^{-4} tons

Electrical Uses

Electric Switches --

Basis of Input Data

1. The 1995 consumption of mercury was 84 Mg (92 tons).[2]

2. A mercury emission factor of 4 kg/Mg (8 lb/ton) of mercury consumed for overall electrical apparatus manufacture was obtained from a 1973 EPA report.[1] This factor pertains only to emissions generated at the point of manufacture.

3. This factor should be used with caution as it is based on engineering judgment and not on actual test data. In addition, fluorescent lamp production and the mercury control methods used in the industry have likely changed considerably since 1973. The emission factor may, therefore, substantially overestimate mercury emissions from this industry.

Calculation

$$\text{Total 1995 emissions} = 92 \text{ tons} \times \frac{8 \text{ lb}}{\text{ton}} = 736 \text{ lb} \quad \text{or} \quad 0.4 \text{ tons}$$

$$= 84 \text{ Mg} \times \frac{4 \text{ kg}}{\text{Mg}} = 336 \text{ kg} \quad \text{or} \quad 0.3 \text{ Mg}$$

Thermal Sensing Elements --

No emission factors are available for mercury emissions from this process.

Tungsten Bar Sintering --

No emission factors are available for mercury emissions from this process.

Copper Foil Production --

No emission factors are available for mercury emissions from this process.

Fluorescent Lamp Manufacture --

Basis of Input Data

1. The 1995 consumption of mercury was 30 Mg (33 tons).[2]

2. A mercury emission factor of 4 kg/Mg (8 lb/ton) of mercury consumed for overall electrical apparatus manufacture was obtained from a 1973 EPA report.[1] This factor pertains only to emissions generated at the point of manufacture.

3. This factor should be used with caution as it is based on engineering judgment and not on actual test data. In addition, fluorescent lamp production and the mercury control methods

used in the industry have likely changed considerably since 1973. The emission factor may, therefore, substantially overestimate mercury emissions from this industry.

Calculation

$$\text{Total 1995 emissions} = 33 \text{ tons} \times \frac{8 \text{ lb}}{\text{ton}} = 264 \text{ lb} = 0.1 \text{ tons}$$

$$= 30 \text{ Mg} \times \frac{4 \text{ kg}}{\text{Mg}} = 120 \text{ kg} = 0.1 \text{ Mg}$$

Fluorescent Lamp Recycling --

Basis of Input Data

1. Data from a 1994 EPA report indicate that approximately 600 million fluorescent lamps are disposed each year, with only 2 percent of that number (or 12 million lamps) being recycled annually.[6]

2. A mercury emission factor of 0.00088 mg/lamp (or 1.9×10^{-9} lb/lamp) was obtained from a 1994 test report for one fluorescent lamp crusher.[7]

3. A large degree of uncertainty is associated with this emission estimate because of the limited data from which the emission factor was developed.

Calculation

$$\text{Total 1994 emissions} = \frac{12 \times 10^6 \text{ lamps}}{\text{yr}} \times \frac{8.8 \times 10^{-4} \text{ mg}}{\text{lamp}} = 10.56 \times 10^3 \text{ mg}$$

$$= 10.56 \text{ g}$$

$$= 0.011 \text{ kg}$$

$$= 1.1 \times 10^{-5} \text{ Mg}$$

$$\text{or } 1.2 \times 10^{-5} \text{ tons}$$

Measurement and Control Instrument Manufacturing

Basis of Input Data

1. In 1995, 43 Mg (47 tons) of mercury were used in all measuring and control instrument manufacture.[2]

2. A 1973 EPA report presents an emission factor for overall instrument manufacture of 9 kg/Mg (18 lb/ton) of mercury consumed.[1]

3. This emission factor should be used with caution as it is based on survey responses gathered in the 1960's and not on actual test data. In addition, instrument production and the mercury control methods used in the industry have likely changed considerably since the time of the surveys.

Calculation

$$\text{Total 1995 emission} = 47 \text{ tons} \times \frac{18 \text{ lb}}{\text{ton}} = 846 \text{ lb} = 0.4 \text{ tons}$$

$$43 \text{ Mg} \times \frac{9 \text{ kg}}{\text{Mg}} = 387 \text{ kg} = 0.4 \text{ Mg}$$

SECTION 6

EMISSIONS FROM COMBUSTION SOURCES

Coal Combustion

Coal-Fired Utility Boilers --

Basis of Input Data

1. Develop average mercury emission concentrations for the major coal seams in the USGS data base and identify these seams with States.

2. Using the UDI/EEI data base of specific boiler configurations, calculate the mercury input to each boiler by matching coal from States in (1) and multiplying the mercury content of the coal by the boiler annual coal consumption rate.

3. Adjust the mercury input in (2) for those boilers burning bituminous coal located east of the Mississippi River as a result of coal cleaning by multiplying the input in (2) by 0.79 (a 21 percent reduction in mercury content).

4. Multiply the resulting mercury input from (2) or (3) by the EMF factor that applies to the particular boiler. The EMF factors are found in Table B-1, Appendix B.

5. Sum the estimated mercury emissions for each boiler.

6. The total nationwide mercury emission estimate from utility coal-fired boilers is 46.3 Mg/yr (51 tons/yr).

Coal-Fired Industrial Boilers --

Basis of Input Data

1. From Table 6-8, emission factor for bituminous coal combustion = 7.0×10^{-15} kg/J and for anthracite coal combustion = 7.6×10^{-15} kg/J.

2. No control of emissions from industrial boilers was assumed.

3. Energy from coal combustion in industrial sector from Table 6-1.

Calculations

$$\text{Total 1994 emissions} = 7.0 \times 10^{-15}\ \text{kg/J} * 2.892 \times 10^{18}\ \text{J/yr} + 7.6 \times 10^{-15}\ \text{kg/J} * 0.009 \times 10^{18}\ \text{J/yr} = 20.3\ \text{Mg} = 22.3\ \text{tons}$$

Coal-Fired Commercial and Residential Boilers --

Basis of Input Data

1. From Table 6-8, emission factor for bituminous coal combustion = 7.0×10^{-15} kg/J and for anthracite coal combustion = 7.6×10^{-15} kg/J.

2. No control of emissions from commercial/residential boilers was assumed.

3. Energy from coal combustion in commercial/residential sectors from Table 6-1.

Calculations

$$\begin{aligned}\text{Total 1994 emissions} &= 7.0 \times 10^{-15}\ \text{kg/J} * 0.130 \times 10^{18}\ \text{J/yr}\\ &\quad + 7.6 \times 10^{-15}\ \text{kg/J} * 0.032 \times 10^{18}\ \text{J/yr}\\ &= 1.2\ \text{Mg} = 1.3\ \text{tons}\end{aligned}$$

Oil Combustion

Oil-Fired Utility Boilers --

Basis of Input Data

1. From Table 6-15, emission factor for distillate oil combustion = 2.7×10^{-15} kg/J and for residual oil combustion = 0.2×10^{-15} kg/J.

2. Air pollution control measures assumed to provide no mercury emission reduction.

3. Energy consumption from fuel oil combustion from Table 6-1.

Calculations

$$\begin{aligned}\text{Total 1994 emissions} &= 2.7 \times 10^{-15}\ \text{kg/J} * 0.100 \times 10^{18}\ \text{J/yr}\\ &\quad + 0.2 \times 10^{-15}\ \text{kg/J} * 0.893 \times 10^{18}\ \text{J/yr}\\ &= 0.45\ \text{Mg} = 0.49\ \text{tons}\end{aligned}$$

Oil-Fired Industrial Boilers --

Basis of Input Data

1. From Table 6-15, emission factor for distillate oil combustion = 2.7×10^{-15} kg/J and for residual oil combustion = 0.2×10^{-15} kg/J.

2. Air pollution control measures assumed to provide no mercury emission reduction.

3. Energy consumption from fuel oil combustion from Table 6-1.

Calculations

$$\begin{aligned}\text{Total 1994 emissions} &= 2.7 \times 10^{-15}\ \text{kg/J} * 1.169 \times 10^{18}\ \text{J/yr}\\ &\quad + 0.02 \times 10^{-15}\ \text{kg/J} * 0.448 \times 10^{18}\ \text{J/yr}\\ &= 3.2\ \text{Mg} = 3.6\ \text{tons}\end{aligned}$$

Oil-Fired Commercial/Residential Boilers --

Basis of Input Data

1. From Table 6-15, emission factor for distillate oil combustion = 2.7×10^{-15} kg/J and for residual oil combustion = 0.2×10^{-15} kg/J.

2. Air pollution control measures assumed to provide no mercury emission reduction.

3. Energy consumption from fuel oil combustion from Table 6-1.

Calculations

$$\begin{aligned}\text{Total 1994 emissions} &= 2.7 \times 10^{-15}\ \text{kg/J} * 1.417 \times 10^{18}\ \text{J/yr}\\ &\quad + 0.2 \times 10^{-15}\ \text{kg/J} * 0.184 \times 10^{18}\ \text{J/yr}\\ &= 3.9\ \text{Mg} = 4.3\ \text{tons}\end{aligned}$$

Wood Combustion

Industrial Boilers --

Basis of Input Data

1. NCASI Technical Bulletin 701 gives an average emission factor for mercury emissions from wood-fired boilers with ESP's of 1.3×10^{-6} kg/Mg (2.6×10^{-6} lb/ton) dry wood fuel.

2. Total U.S. wood-fired boiler capacity is assumed to be 1.04×10^{11} Btu/hr, which is the same rate as 1980.[8]

3. Heating value of dry wood fuel is 18×10^{6} Btu/ton.

4. The U.S. wood consumption rate:

$$\frac{1.04 \ \text{x} \ 10^{11} \ \text{Btu/hr}}{18 \ \text{x} \ 10^{6} \ \text{Btu/ton}} = 5{,}778 \ \text{tons (dry)/hr}$$

Assuming operation at capacity for 8,760 hours/year, total annual wood consumption =

5,778 tons/year x 8,760 hr/yr = 50,615,280 tons/yr

Calculation

Total 1994 emissions = 50.62×10^{6} tons/yr x 2.6×10^{-6} lb Hg/ton

= 132 lb Hg/hr

= 0.1 tons or 0.1 Mg

Residential Wood Stoves --

No emission factors are available for mercury emissions from this process.

Residential Fireplaces --

No emission factors are available for mercury emissions from this process.

Municipal Waste Combustion --

Basis of Input Data

1. The following average concentrations presented in "National Emissions for Municipal Waste Combustors" were applied to the inventory of municipal waste combustors (provided in Appendix B) to determine the nationwide emissions for refused derived fuel (RDF) and non-RDF combustors:[9]

Combustor type	Average mercury concentration, ug/dscm @ 7% O_2
Non-RDF without acid gas control	340
Non-RDF with acid gas control	205
Non-RDF with acid gas control and carbon	19
RDF without acid gas control	260
RDF with acid gas control	35

2. The F-factor used for municipal waste combustors was 9,570 dscf/MMBtu at 0 percent oxygen. Higher heating values were given as 4,500 Btu/lb for unprocessed MSW, and 5,500 Btu/lb for RDF.[9]

3. Average capacity factors, which represent the percentage of operational time a plant would operate during a year at 100 percent capacity, were presented in the EPA report on mercury emissions from municipal waste combustors.[9] For all units, except modular/starved-air combustors, the annual capacity factor was 91 percent (0.91). For modular/starved-air combustors, the annual capacity factor was 74 percent (0.74).

Calculations

1. The F-factor and higher heating values were used to develop volumetric flow factors for non-RDF and RDF units as follows:

   Volumetric flow factor (non-RDF) = (9,750 dscf @ 0%O_2/MMBtu) * (4,500 Btu/lb) * (2,000 lb/ton) * (20.9/(20.9-7))/(35.31 dscf/dscm)/(10^6 Btu/MMBtu) = 3,670 dscm @ 7% O_2/ton MSW

   Volumetric flow factor (RDF) = (9,750 dscf @ 0%O_2/MMBtu) * (5,500 Btu/lb) * (2,000 lb/ton) * (20.9/(20.9-7))/(35.31 dscf/dscm)/(10^6 Btu/MMBtu) = 4,457 dscm @ 7% O_2/ton RDF

2. The following equation was used to convert the mercury stack concentrations to megagrams per year for each unit in the municipal waste combustor inventory:

$$E = C \times V \times T \times CF / 10^{12}$$

where:

E = annual mercury emissions (Mg/yr)
C = flue gas mercury concentration (ug/dscm @ 7% O_2)
V = volumetric flow factor (dscm @ 7% O_2/ton waste)
T = MWC unit capacity (ton/year), and
CF = capacity factor (unitless).

The annual mercury emissions from each MWC in the inventory were summed to determine the nationwide mercury emissions from municipal waste combustors. The total nationwide emissions of mercury from municipal waste combustors are 26 Mg/yr (29 ton/yr).

Sewage Sludge Incinerators --

Basis for Input Data

1. Total sludge processed in 1995 was 785,000 Mg (864,000 tons).[10]

2. From the Draft AP-42, Section 2.2, Sewage Sludge Incineration, an average emission factor for units with a venturi control device was 0.018 g/Mg (3.5×10^{-5} lb/ton). For other control devices, the average emission factor was 1.6 g/Mg (3.2×10^{-3} lb/ton).[11]

3. In the U.S., there are 166 active sewage sludge incinerators; of this population, 47 use venturi control devices, 97 use other control devices, and no information was available for 22 units. Of the 144 units for which data are available, 47/144 or 33 percent use venturi controls and 97/144 or 67 percent use other controls. This percentage distribution is assumed to be representative for all 166 units.[10,11]

Calculation

Total 1995 emissions = 785,000 Mg/yr x 0.33 x 0.018 g/Mg + 785,000 x 0.67 x 1.6 g/Mg
= 0.86 Mg
= 0.94 tons

Hazardous Waste Combustion --

Basis of Input Data

1. Mercury national emissions estimate data were obtained from the EPA Office of Solid Waste Studies for the proposed hazardous waste combustion MACT standards. Details on the methodologies used to estimate the mercury emissions from hazardous waste incinerators, cement kilns, and lightweight aggregate kilns may be obtained from docket materials prepared by the EPA Office of Solid Waste for the proposed hazardous waste combustion MACT standards.[12]

2. For 1996, emissions from cement kilns permitted to burn hazardous waste were derived by EPA for the 41 hazardous waste burning cement kilns in the United States. The national mercury emissions estimate for cement kilns is 5,860 lb/yr. This corresponds to 2.66 Mg/yr (2.93 tons/yr).

3. For 1996, emissions from hazardous waste incinerators were derived by EPA for 190 units in operation.[13] The national mercury emissions estimate for incinerators is 7,700 lb/yr. This corresponds to 3.5 Mg/yr (3.95 tons/yr).

4. For 1996, emissions from lightweight aggregate kilns were derived by EPA based on 11 kilns. The national mercury emissions estimate for lightweight aggregate kilns is 156 lb/yr. This corresponds to 0.07 Mg/yr (0.08 tons/yr).

Calculation

Total annual emissions = 2.7 Mg + 3.5 Mg + 0.07 Mg = 6.27 Mg
= 6.3 Mg = 6.9 tons

Medical Waste Incineration --

Basis of Input Data

1. The annual emission estimates are based on the calculation procedure employed in developing the environmental impacts of the emission guidelines for medical waste incinerators (MWI's). An inventory of existing MWI's was the basis of the emission calculations for the emission guidelines.

2. The waste incineration capacity of each MWI was included in the inventory. Waste was assumed to be charged at two-thirds of the design capacity because average hourly waste charging rates measured during emissions testing are about two-thirds of the design rate specified by MWI manufacturers.

3. The type of emissions control at each facility was estimated based on applicable State permit limits.

4. The annual hours of operation for each MWI was based on the hours of operation for model plants.

Calculation

1. The annual emissions for each MWI in the inventory was calculated with the following formula:

   Emission (lb/yr) = C x H x R x F

   where, C is the MWI design capacity (lb/hr), H is the annual charging hours (hr/yr), R is the ratio of the actual charging rate to the design capacity (2/3), and F is the emission factor for the appropriate level of control (from Table 6-20).

2. The total emissions from all MWI's in the inventory were calculated by summing the emissions for each individual unit as shown below.[14]

$$\text{Annual emissions} = \sum_{i=1}^{2,400} \text{emissions for each MWI } i$$

$$= 32,000 \text{ lb/yr} = 16.0 \text{ tons} = 14.5 \text{ Mg}$$

SECTION 7
EMISSIONS FROM MISCELLANEOUS SOURCES

Portland Cement Manufacturing --

Basis of Input Data

1. The estimated 1995 total production of clinker from nonhazardous waste fueled kilns was 62.3×10^6 Mg (68.7×10^6 tons). These clinker production levels were estimated using the same percentage of total clinker production from nonhazardous waste fueled kilns as cited by RTI.[15]

2. The average emission factor is 6.5×10^{-5} kg/Mg (1.3×10^{-4} lb/ton) of clinker produced.[15]

Calculation

Total 1994 emissions = 62.3×10^6 Mg x 6.5×10^{-5} kg/Mg = 4.0 Mg = 4.4 tons

This mercury emission estimate is for the use of nonhazardous waste as a fuel; emission estimates for cement kilns burning hazardous waste are presented in Section 6, Hazardous Waste Combustion.

Lime Manufacturing --

Basis of Input Data

1. The estimated 1994 total production of lime was 17.4×10^6 Mg (19.2×10^6 tons).[16]

2. An emission factor of 7.4×10^{-6} kg/Mg of lime produced (1.5×10^{-5} lb/ton) is used for coal-fired rotary kilns and 1.5×10^{-6} kg/Mg of lime produced (3.0×10^{-6} lb/ton) for natural gas-fired vertical kilns.[17,18]. Natural gas is used to fire 33 percent of the lime kilns.

Calculation

Total 1994 emissions = 17.4×10^6 Mg x 7.4×10^{-6} kg/Mg x 0.67 +17.4×10^6 Mg x 1.5×10^{-6} kg/Mg x 0.33 = 86 kg + 8.6 kg = 95 kg

95 kg = 0.095 Mg = 0.10 tons

Carbon Black Manufacturing --

Basis of Input Data

1. The mercury emission factor for the main process vent is 0.15 g/Mg (3×10^{-4} lb/ton).[19]

2. The 1995 total annual production capacity of carbon black is 1,660,000 Mg (1,832,500 tons).[4]

Calculation

The total 1995 emission estimate of mercury from carbon black manufacturing is:

0.15 g/Mg x 1,660,000 Mg/yr = 249,000 g = 0.25 Mg

or

0.00030 lb/ton x 1,832,500 ton/yr = 550 lb = 0.28 ton

By-Product Coke Production --

Basis of Input Data

1. No mercury emission data are available for U.S. byproduct coke ovens.

2. An emission factor is available for German coke ovens of 6 x 10^{-5} lb/ton coke product.[20]

3. Assume that the U.S. coal cleaning process results in a 20% reduction in mercury emissions from U.S. byproduct coke ovens (see Section 6.1.4.1). This results in a mercury emission factor for U.S. coke ovens of 5 x 10^{-5} lb/ton coke produced.

4. 1991 total U.S. coke production capacity was 71,649 tons/day.[21]

5. Assuming operation 365 days/year, 1991 total annual U.S. coke production capacity was 26.15 x 10^6 tons.

Calculation

$$\text{Total 1991 emissions} = 26.15 \times 10^6 \text{ tons coke} * 5 \times 10^{-5} \frac{\text{lb}}{\text{ton coke}}$$

$$= 1{,}308 \text{ lb}$$

$$= 0.65 \text{ tons} \quad \text{or} \quad 0.59 \text{ Mg}$$

Primary Lead Smelting --

Basis of Input Data

1. Based on background information in the NSPS for lead smelters, 100 units of ore yields 10 units of ore concentrate, 9 units of sinter, and 4.5 units of refined lead.[22]

2. The estimated 1994 lead in ore concentrate quantity was 3.7 x 10^5 Mg (4.07 x 10^5 tons).[23]

3. Recent data from lead ore mines indicates that the mercury content of lead ore concentrate is less than 0.2 ppm.[24] It is assumed that the particulate emissions from the process have the same mercury concentration as the lead ore concentrate (i.e., no concentrating of the mercury occurs). A mercury concentration of 0.2 ppm is used as an upper limit value. Based on this concentration, the mercury content is estimated to be 0.4 x 10^{-3} lb Hg per ton of ore concentrate.

4. The mercury emission factors from AP-42 for three emission sources in the process are:

   a. sinter machine (weak gas): 0.051 kg/Mg (0.10 lb/ton) of sinter produced

   b. sinter building fugitives: 0.118 kg/Mg (0.24 lb/ton) of sinter produced

   c. blast furnace = 0.21 kg/Mg (0.43 lb/ton) of bullion

Calculation

Emissions from sinter machine (weak gas):
0.1 lb/ton * 4.07 x 10^5 tons * 1/0.9 * 0.4 x 10^{-3} = 18.1 lb Hg = 8.23 kg

Emissions from sinter building fugitives:
0.24 lb/ton * 4.07 x 10^5 tons * 1/0.9 * 0.4 x 10^{-3} = 43.4 lb Hg = 19.73 kg

Emissions from blast furnace:
0.43 lb/ton * 4.07 x 10^5 tons * 1/0.45 * 0.4 x 10^{-3} = 155.6 lb Hg = 70.73 kg

Total 1994 emissions:
18.1 lb + 43.4 lb + 155.6 lb = 217.1 lb = 0.11 tons = 0.10 Mg

Primary Copper Smelting --

Basis of Input Data

1. In 1993, the Emission Standards Division requested all eight of the primary copper smelters in operation for data on mercury emissions.

2. With the exclusion of Copper Range, which is closed, the total of the self-reported values for mercury emissions in 1993 was 0.055 Mg (0.06 tons).[25]

3. In 1994, smelter production from domestic and foreign ores increased 3.15 percent over 1993 production.[26]

Calculation

Total 1994 emissions = 0.055 Mg x 1.0315 = 0.057 Mg = 0.063 tons

Petroleum Refining --

No reliable emission factors are available for mercury emissions.

Municipal Solid Waste Landfills --

Basis of Input Data

1. The average mercury concentration in landfill gas is 2.9 x 10^{-4} ppmV.[27,28]

2. Methane emissions from landfills in 1994 totaled 10.2 x 10^6 Mg (11.2 x 10^6 tons).[29]

3. The methane gas volume was:

Volume = 2.24 x 10^{10} lb/yr x 1/16 (lb mole/lb methane) x 385.3 dscf/lb mole = 5.394 x 10^{11} dscf/yr

4. The total landfill gas volume is twice the methane volume, or 1.079 x 10^{12} dscf/yr.[29]

Calculation

Total 1994 emissions = 2.9 x 10^{-4} ppm x 10^{-6} x 1.079 x 10^{12} dscf/yr x 200.59 lb Hg/lb mole x 1 lb mole/385.3 dscf

= 162.9 lb Hg = 0.081 tons = 0.074 Mg

Geothermal Power Plants --

Basis of Input Data

1. The mercury emission factors for geothermal power plants are:[30]

   Off-gas ejectors: 0.00725 g/MWe/hr (0.00002 lb/MWe/hr)

   and

   Cooling tower exhaust: 0.05 g/MWe/hr (0.0001 lb/MWe/hr)

2. The total annual capacity (MW) of U. S. geothermal power plants in 1993 was 2,653 MW.[31,32]

3. Assumption: All plants operate at capacity, 24 hrs per day, 365 days per year.

4. Based on the above assumption, annual capacity in MW hr is:

   2,653 MW x 24 hr/day x 365 days/yr = 2.32×10^7 MW hr

Calculation

The total 1993 emission estimate of mercury from geothermal power plants based on the above capacity data and assumption is:

2.32×10^7 MW hr x (0.00725 + 0.05) g/MWe/hr x 10^{-6} Mg/g= 1.3 Mg = 1.4 tons

Pulp and Paper Production --

Basis of Input Data

1. The nationwide daily black liquor solids firing rate for kraft and soda recovery furnaces is 2.36×10^5 Mg/d (2.60×10^5 tons/d).[33] The same firing rate also applies to kraft and soda SDT's, which are associated with the recovery furnaces. The nationwide daily lime production rate for kraft and soda lime kilns is 3.76×10^4 Mg/d (4.15×10^4 tons/d).[34]

2. Kraft and soda combustion sources nationwide are assumed to operate 24 hr/d for 351 d/yr. This operating time accounts for 14 days of scheduled shutdown annually for maintenance and repair.

3. The chemical recovery areas at kraft and soda pulp mills are considered sufficiently similar to justify applying the mercury emission factors for the kraft combustion sources to the soda combustion sources. No information is available on mercury emission factors for sulfite or stand-alone semichemical pulp mills, and the two processes are sufficiently different from the kraft process that the mercury emission factors for the kraft combustion sources were not applied to the sulfite and semichemical combustion sources. Therefore, mercury emissions for the sulfite and semichemical combustion sources will not be included in the nationwide mercury emission estimate.

4. The average mercury emission factor for kraft and soda recovery furnaces is 1.95×10^{-5} kg/Mg (3.90×10^{-5} lb/ton) of black liquor solids fired. The average mercury emission factor for kraft and soda SDT's is 2.61×10^{-8} kg/Mg (5.23×10^{-8} lb/ton) of black liquor solids fired. The average mercury emission factor for kraft and soda lime kilns is 1.46×10^{-6} kg/mg (2.91×10^{-6} lb/ton) of lime produced.[35]

Calculation

Emissions from kraft and soda recovery furnaces = 1.95×10^{-5} kg/Mg * 2.36×10^5 Mg/d * 351 d/yr = 1.62×10^3 kg/yr = 1.62 Mg/yr

Emissions from kraft and soda SDT's = 2.61×10^{-8} kg/Mg * 2.36×10^{5} Mg/d * 351 d/yr = 2.16 kg/yr = 0.00216 Mg/yr

Emissions from kraft and soda lime kilns = 1.46×10^{-6} kg/Mg * 3.76×10^{4} Mg/d * 351 d/yr = 19.3 kg/yr = 0.0193 Mg/yr

Total 1994 emissions from kraft and soda combustion sources = 1.62 Mg + 0.00216 Mg + 0.0193 Mg = 1.64 Mg = 1.81 ton

SECTION 8
EMISSIONS FROM MISCELLANEOUS FUGITIVE AND AREA SOURCES

Mercury Catalysts --

No data are available for any quantities of mercury used for catalytic purposes. Zero emissions have been assumed.

Dental Alloys --

Basis of Input Data

1. In 1995, the total use of mercury in dental equipment and supplies was 32 Mg (35 tons).[2]

2. It has been estimated that 2.0 percent of the mercury used in dental applications is emitted to the atmosphere.[36] This would correspond to an emission factor of 20 kg/Mg (40 lb/ton) of mercury used.

Calculation

Total 1995 emissions = 32 Mg x 20 kg/Mg = 0.64 Mg = 0.70 tons

Mobile Sources --

No reliable emission factors are available for mercury emissions from mobile sources.

Crematories --

Basis for Input Data

1. In 1995, there were 488,224 cremations in the U.S.[37]

2. Only one set of data are available for the average quantity of mercury emitted for a cremation in the U.S. The estimated average emission factor is 1.5×10^{-3} kg (3.3×10^{-3} lb) per cremation.[38] This emission factor will be used for estimations for the U.S.

Calculation

$$\text{Total 1995 emissions} = \frac{1.5 \times 10^{-3}\ \text{kg}}{\text{cremation}} \times 488{,}224\ \text{cremations}$$
$$= 0.732\ \text{kg} = 0.73\ \text{Mg} = 0.80\ \text{tons}$$

Paint Use --

All registrations for mercury-based biocides in paints were voluntarily canceled by the registrants in May 1991. Based on the voluntary cancellation, it is assumed that mercury emissions from this source are very small or zero.

Soil Dust --

There are no emission factors for mercury emissions from soil dust.

Natural Sources of Mercury Emissions --

There are no emission factors for mercury emissions from natural sources.

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APPENDIX B

SUMMARY OF COMBUSTION SOURCE MERCURY EMISSION DATA

TABLE B-1. EMISSION MODIFICATION FACTORS FOR UTILITY BOILER EMISSION ESTIMATES[a]

Type of APCD or boiler	EMF factor
Fabric filter	0.626
Spray dryer adsorber (includes a fabric filter)	0.701
Electrostatic precipitator (cold-side)	0.684
Electrostatic precipitator (hot-side)	1.000
Electrostatic precipitator (oil-fired unit)	0.315
Particulate matter scrubber	0.957
Fluidized gas desulfurization scrubber	0.715
Circulating fluidized bed scrubber	1,000
Cyclone-fired boiler without NO_x control (wet bottom, coal-fired)	0.856
Front-fired boiler without NO_x control (dry bottom, coal-fired)	0.706
Front-fired boiler without NO_x control (dry bottom, gas-fired)	1.000
Tangential-fired boiler without NO_x control (before a hot-side ESP, coal-fired)	1.000
Tangential-fired boiler with NO_x control (before a hot-side ESP, coal-fired)	0.748
Front-fired boiler without NO_x control (dry bottom, oil-fired)	1.000
Front-fired boiler with NO_x control (dry bottom, oil-fired)	1.000
Opposed-fired boiler without NO_x control (dry bottom oil-fired)	0.040
Tangentially-fired boiler without NO_x control (dry bottom, oil-fired)	1.000
Tangentially-fired boiler with NO_x control (dry bottom, oil-fired)	1.000
Opposed-fired boiler with NO_x control (dry bottom, coal-fired)	0.812
Front-fired boiler without NO_x control (wet bottom, coal-fired)	0.918
Tangentially-fired boiler without NO_x control (dry bottom, coal-fired)	1.000
Tangentially-fired boiler with NO_x control (dry bottom, coal-fired)	0.625
Vertically-fired boiler with NO_x control (dry bottom, coal-fired)	0.785

[a]To calculate mercury control efficiency for a specific boiler/control device configuration, the EMF is subtracted from 1.

Source: Mercury Study Report to Congress, Volume II: An Inventory of Anthropogenic Mercury Emissions in the United States. EPA-452/8-96-001b. June 1996.

TABLE B-2. SUMMARY OF MUNICIPAL WASTE COMBUSTOR DATA

Unit name	Location	State	Project status	Total plant capacity, tons/d	No. of units	Combustor type	Air pollution control devices
Juneau RRF	Juneau	AK	OP	70	2	MOD/SA	ESP
Sitka WTE Plant	Sitka	AK	OP	50	1	MOD/EA	ESP DSI
Huntsville Refuse-Fired Steam Fac.	Huntsville	AL	OP	690	2	MB/WW	FF SD
Tuscaloosa Solid Waste Fac.	Tuscaloosa	AL	IA	300	4	MOD/SA	ESP
Batesville	Batesville	AR	OP	100	2	MOD/SA	None
Blytheville Incinerator	Blytheville	AR	OP	70	2	MOD/SA	None
North Little Rock RRF	North Little Rock	AR	IA	100	4	MOD/SA	None
Osceola	Osceola	AR	OP	50	2	MOD/SA	None
Stuttgart Incinerator	Stuttgart	AR	OP	63	5	MOD/SA	None
Commerce Refuse-to-Energy Fac.	Commerce	CA	OP	380	1	MB/WW	FF SD SNCR
Lassen Community College	Susanville	CA	IA	100		MOD	FF DSI
Long Beach (SERRF)	Long Beach	CA	OP	1,380	3	MB/WW	FF SD SNCR
Modesto	Crows Landing	CA	OP	800	2	MB/WW	FF SD SNCR
Bridgeport RESCO	Bridgeport	CT	OP	2,250	3	MB/WW	FF SD
Bristol RRF	Bristol	CT	OP	650	2	MB/WW	FF SD
Lisbon RRF	Lisbon	CT	UC	500		MB/WW	FF SD SNCR
Mid-Connnecticut Project	Hartford	CT	OP	2,000	3	RDF	FF SD
Southeastern Connecticut RRF	Preston	CT	OP	600	2	MB/WW	FF SD
Stamford I	Stamford	CT	IA	150	1	MB/REF	ESP
Stamford II Incinerator	Stamford	CT	IA (1994)	360	1	MB/REF	ESP
Town of New Canaan Volume Reduction Plant	New Canaan	CT	OP	125	1	MB/REF	WS
Wallingford RRF	Wallingford	CT	OP	420	3	MOD/EA	FF SD
Windham RRF	Windham	CT	IA	108	3	MOD/SA	FF SD
Solid Waste Reduction Center No.1	Washington	DC	IA	1,000	4	MB/REF	ESP
Kent		DE	On Hold	1,800		MB	None
Pigeon Point	Wilmington	DE	IA	600	5	MOD	ESP
Sussex		DE	On Hold	600			None
Bay Resource Mgt. Center	Panama City	FL	OP	510	2	MB/RC	ESP
Broward Co. RRF North	Pompano Beach	FL	OP	2,250	3	MB/WW	FF SD
Broward Co. RRF South	Pompano Beach	FL	OP	2,250	3	MB/WW	FF SD
Dade Co. RRF	Miami	FL	OP	3,000	4	RDF	ESP
Dade Co. RRF Expansion	Miami	FL	On Hold	750			FF SD SNCR CI
Hillsborough Co. RRF	Tampa	FL	OP	1,200	3	MB/WW	ESP
Lake Co. RR	Okahumpka	FL	OP	528	2	MB/WW	FF SD
Lee Co. RRF	Fort Myers	FL	UC	1,200	2	MB/WW	FF SD SNCR CI
Mayport NAS	Mayport NAS	FL	OP	50	1	MOD/EA	Cyc
McKay Bay REF	Tampa	FL	OP	1,000	4	MB/REF	ESP
Miami International Airport	Miami	FL	OP	60	1	MOD/SA	None
North Co. Region RR Project	West Palm Beach	FL	OP	2,000	2	RDF	ESP SD
Pasco Co. Solid Waste RRF	Hudson	FL	OP	1,050	3	MB/WW	FF SD
Southernmost WTE	Key West	FL	OP	150	2	MB/WW	ESP
Wheelabrator Pinellas RRF	St. Petersburg	FL	OP	3,000	3	MB/WW	ESP

TABLE B-2. (continued)

Unit name	Location	State	Project status	Total plant capacity, tons/d	No. of units	Combustor type	Air pollution control devices
Savannah RRF	Savannah	GA	OP	500	2	MB/WW	ESP FF(r) SD(r)
Honolulu Resource Recovery Venture	Honolulu	HI	OP	2,160	2	RDF	ESP SD
Waipahu Incinerator	Honolulu	HI	IA	600	2	MB/REF	ESP
Burley	Burley	ID	OP	50	1	MOD/SA	None
Beardstown	Beardstown	IL	P	1,800		RDF	FF SD SNCR
Havana WTE Fac.	Havana	IL	P	1800		RDF	FF SD SNCR
Northwest WTE	Chicago	IL	OP	1,600	4	MB/WW	ESP
Robbins RRF	Robbins	IL	P	1,600		RDF/FB	FF SD SNCR
West Suburban Recycling and Energy Center	Summit	IL	P	1,800	2	RDF/WW	FF SD SNCR
Bloomington	Bloomington	IN	On Hold	300		MB	FF SD SNCR
Indianapolis RRF	Indianapolis	IN	OP	2,362	3	MB/WW	FF SD
Kentucky Energy Assoc.	Corbin	KY	P	500		MB	
Louisville Energy Generating Fac.	Louisville	KY	On Hold	250		RDF/FB	Cyc FF SNCR
Louisville Incinerator	Louisville	KY	IA	100	4	Unknown	WS
Fall River Incinerator	Fall River	MA	OP	600	2	MB/REF	WS
Framingham	Framingham	MA	IA	500	2	MB/REF	FF SD
Haverhill Lawrence RDF	Lawrence	MA	OP	710	1	RDF	ESP FSI(r)
Haverhill RRF	Haverhill	MA	OP	1,650	2	MB/WW	ESP SD
Montachusetts RRF	Shirley	MA	UC	243		MB/WW	FF SD SNCR CI
North Andover RESCO	North Andover	MA	OP	1,500	2	MB/WW	ESP FSI(r)
Pittsfield RRF	Pittsfield	MA	OP	240	2	MOD/EA	ESP WS
Saugus RESCO	Saugus	MA	OP	1,500	2	MB/WW	FF(r) SD(r)
SEMASS RRF Units 1 & 2	Rochester	MA	OP	1,800	2	RDF	ESP SD
SEMASS RRF Unit 3		MA	OP	900	1		FF SD SNCR
Springfield RRF	Agawan	MA	OP	360	3	MOD	FF DSI
Wheelabrator Millbury	Millbury	MA	OP	1,500	2	MB/WW	ESP SD
Harford Co. WTE Fac.	Aberdeen Proving Grounds	MD	OP	360	4	MOD/SA	ESP
Montgomery Co. North RRF Unit #2		MD	OP	300	1	MB/RC/REF	ESP FSI
Montgomery Co. North RRF Unit #3		MD	OP	300	1	MB/RC/REF	ESP FSI
Montgomery Co. RRF	Dickerson	MD	UC	1,800		MB/WW	FF SD SNCR CI
Montgomery Co. South RRF Unit #2		MD	OP	300	1	MB/RC/REF	ESP FSI
Montgomery Co. South RRF Unit #3		MD	OP	300	1	MB/RC/REF	ESP FSI
Pulaski	Baltimore	MD	OP	1,500	5	MB/REF	ESP
Southwest RRF (RESCO)	Baltimore	MD	OP	2,250	3	MB/WW	ESP
Frenchville	Frenchville	ME	IA	50	1	Unknown	None
Greater Portland Region RRF	Portland	ME	OP	500	2	MB/WW	ESP SD
Maine Energy Recovery	Biddeford - Saco	ME	OP	600	2	RDF	FF SD

TABLE B-2. (continued)

Unit name	Location	State	Project status	Total plant capacity, tons/d	No. of units	Combustor type	Air pollution control devices
Mid Maine Waste Action Corp.	Auburn	ME	OP	200	2	MB	FF SD
Penobscot Energy Recovery Comp.	Orrington	ME	OP	700	2	RDF	FF SD
Central Wayne Co. Sanitation Auth	Dearborn Heights	MI	OP	500	2	RDF	ESP
Clinton Township	Clinton Township	MI	OP	600	2	MB/REF	ESP
Greater Detroit RRF Unit #1	Detroit	MI	OP	1,100	1	RDF	FF(r) SD(r)
Greater Detroit RRF Unit #2		MI	OP	1,100	1	RDF	FF(r) SD(r)
Greater Detroit RRF Unit #3		MI	OP	1,100	1	RDF	FF(r) SD(r)
Jackson Co. RRF	Jackson	MI	OP	200	2	MB/WW	FF SD
Kent Co. WTE Fac.	Grand Rapids	MI	OP	625	2	MB/WW	FF SD
Oakland Co. WTE Fac.	Auburn Hills	MI	On Hold	2,000		MB	FF SD CI
Elk River FFR	Anoka	MN	OP	1,500	3	RDF	FF DSI
Fergus Falls	Fergus Falls	MN	OP	94	2	MOD/SA	WS
Hennepin Energy Recovery Facility	Minneapolis	MN	OP	1,200	2	MB/WW	FF SD SNCR CI(r)
Olmstead WTE Facility	Rochester	MN	OP	200	2	MB/WW	ESP
Perham Renewable RF	Perham	MN	OP	114	2	MOD/SA	ESP
Polk Co. Solid Waste Resource Recovery	Fosston	MN	OP	80	2	MOD/SA	ESP
Pope-Douglas Solid Waste	Alexandria	MN	OP	72	2	MOD/EA	ESP
Ramsey-Washington	Red Wing	MN	OP	720	2	RDF	ESP
Red Wing Solid Waste Boiler Facility	Red Wing	MN	OP	72	2	MOD/EA	ESP
Richards Asphalt Co. Facility	Scott	MN	OP	70	1	MOD	ESP
Western Lake Superior Sanitary District	Duluth	MN	OP	260	2	RDF	VS
Wilmarth Plant	Mankato	MN	OP	720	2	RDF	FF(r) SD(r)
Ft Leonard Wood RRF	Ft Leonard Wood	MO	IA	78	3	MOD/SA	None
St Louis WTE	St Louis	MO	P	1,200			FF SD SNCR
Pascagoula Energy Recovery Facility	Moss Point	MS	OP	150	2	MOD/EA	ESP
Livingston/Park County MWC	Park County	MT	OP	72	2	MOD/SA	None
Carolina Energy Corp	Kinston	NC	P	600	1	RDF	FF DSI SNCR CI
Fayetteville RRF	Fayetteville	NC	UC	600	2	RDF/FB	DSI SNCR CI
New Hanover Co. WTE Unit 1 & 2	Wilmington	NC	OP	200	2	MB/WW	ESP SD(r)
New Hanover Co. WTE Unit 3		NC	OP	249	1	MB/WW	FF SD SNCR
NIEHS	RTP	NC	OP	40	2	MOD/SA	None
University City RRF	Charlotte	NC	OP	235	2	MB/WW	ESP
Wrightsville Beach Incinerator	Wrightsville Beach	NC	IA	50	2	MOD/SA	None
Lamprey Regional SW Coop.	Durham	NH	OP	132	3	MOD/EA	Cyc
Pittsfield Incinerator	Pittsfield	NH	IA	48	2	MOD/SA	None
SES Claremont RRF	Claremont	NH	OP	200	2	MB/WW	FF DSI
Wheelabrator Concord	Concord	NH	OP	500	2	MB/WW	FF DSI
Camden RRF	Camden	NJ	OP	1,050	3	MB/WW	ESP SD CI
Essex Co. RRF	Newark	NJ	OP	2,277	3	MB/WW	ESP SD CI

TABLE B-2. (continued)

Unit name	Location	State	Project status	Total plant capacity, tons/d	No. of units	Combustor type	Air pollution control devices
Fort Dix RRF	Wrightstown	NJ	OP	80	4	MOD/SA	FF WS CI
Gloucester County	Westville	NJ	OP	575	2	MB/WW	FF SD CI
Union Co. RRF	Rahway	NJ	OP	1,440	3	MB/WW	FF SD SNCR CI
Warren Energy RF	Oxford Township	NJ	OP	400	2	MB/WW	FF SD
Adirondack RRF	Hudson Falls	NY	OP	432	2	MB/WW	ESP SD
Albany Steam Plant	Albany	NY	IA	600	2	RDF	ESP
Babylon RRF	Babylon	NY	OP	750	2	MB/WW	FF SD
Betts Ave. Incinerator	Queens	NY	IA	1,000	4	MB/REF	ESP
Cattaraugus Co. WTE Plant	Cuba	NY	IA	112	3	MOD/SA	None
Dutchess Co. RRF	Poughkeepsie	NY	OP	400	2	MB/RC	FF DSI
Glen Cove	Glen Cove	NY	IA	250	2	MB/WW	FF(r) DSI
Green Island WTE Plant	Green Island	NY	P	1,500		MB	FF SD SNCR
Green Point Incinerator	Green Point	NY	IA	100		Unknown	ESP
Hempstead	Westbury	NY	OP	2,505	3	MB/WW	FF SD
Henry St. Incinerator	Brooklyn	NY	IA			Unknown	ESP
Huntington RRF	Huntington	NY	OP	750	3	MB	FF SD SNCR
Kodak RRF	Rochester	NY	OP	150	1	RDF	ESP
Long Beach RRF	Long Beach	NY	OP	200	1	MB/WW	ESP
MacArthur WTE	Islip/Ronkonkoma	NY	OP	518	2	MB/RC	FF DSI
MER Expansion	Islip/Ronkonkoma	NY	On Hold	350		MB	FF
Monroe Co. RRF	Rochester	NY	IA	2,000		RDF	None
Niagara Falls RDF WTE	Niagara Falls	NY	OP	2,200	2	RDF	ESP
Oceanside RRF	Oceanside	NY	IA	750		MB/WW	ESP
Oneida Co. ERF	Rome	NY	OP	200	4	MOD/SA	ESP
Onondaga Co. RRF	Jamesville	NY	UC	990	3	MB/WW	FF SD SNCR CI
Oswego Co. WTE	Fulton	NY	OP	200	4	MOD/SA	ESP
Port of Albany WTE Fac.	Port of Albany	NY	P	1,300		MB	FF SD SNCR CI
South West Brooklyn Incinerator	Brooklyn Bay 41st St.	NY	IA	960	4	MB/REF	FF(r) DSI(r) SD(r) SNCR(r) CI(r)
Westchester RESCO	Peekskill	NY	OP	2,250	3	MB/WW	ESP FSI (r)
Akron Recycle Energy System	Akron	OH	IA	1,000	3	RDF	ESP
City of Columbus SW Reduction Fac.	Columbus	OH	IA	2,000	6	RDF	ESP FF(r) SD(r)
Euclid	Euclid	OH	IA	200	2	MB/REF	ESP
Mad River RRF	Springfield	OH	IP	1,750		MB/WW	FF SD SNCR CI
Montgomery Co. North RRF Unit #1	Dayton	OH	OP	300	1	MB/RC/REF	ESP FSI
Montgomery Co. South RRF Unit #1	Dayton	OH	OP	300	1	MB/RC/REF	ESP FSI
Miami RRF	Miami	OK	OP	105	3	MOD/SA	None
Walter B. Hall RRF	Tulsa	OK	OP	1,125	3	MB/WW	ESP
Coos Bay Incinerator	Coquille	OR	OP	125	3	MOD/SA	None

TABLE B-2. (continued)

Unit name	Location	State	Project status	Total plant capacity, tons/d	No. of units	Combustor type	Air pollution control devices
Marion Co. WTE	Brooks	OR	OP	550	2	MB/WW	FF SD
Delaware Co. RRF	Chester	PA	OP	2,688	6	MB/RC/WW	FF SD
Glendon RR Project	Glendon	PA	P	500		MB/WW	FF SD SNCR CI
Harrisburg WTE	Harrisburg	PA	OP	720	2	MB/WW	ESP
Lancaster Co. RRF	Bainbridge	PA	OP	1,200	3	MB/WW	FF SD
Montgomery Co. RRF	Conshohoken	PA	OP	1,200	2	MB/WW	FF SD
Philadelphia EC	Philadelphia EC	PA	IA	750	2	MB/WW	ESP
Philadelphia NW	Philadelphia NW	PA	IA	750	2	MW/WW	ESP
Potter Co. RR		PA	P	48		MOD	FF SD
Westmoreland WTE Fac.	Greensburg	PA	OP	50	2	MOD/SA	ESP
Wheelabrator Falls RRF	Falls Township	PA	OP	1,500	2	MB/WW	FF SD SNCR CI
York Co. RR Center	Manchester Township	PA	OP	1,344	3	MB/RC/WW	FF SD
San Juan	San Juan	PR	P	1,200	3	MB/WW	FF SD SNCR CI
Central Falls RRF	Central Falls	RI	P	750		MB	None
Johnston RRF	Johnston	RI	P	750		MB/WW	FF SD SNCR CI
North Kingston Solid Waste Fac.	North Kingston	RI	P	750		MB	None
Quonset Point RRF	Quonset Point	RI	P	710		MB/WW	FF SD SNCR CI
Chamber Medical Tech. of SC	Hampton	SC	OP	270	3	MOD/SA	ESP DSI SD
Foster Wheeler Charleston RR	Charleston	SC	OP	600	2	MB/WW	ESP SD
Dyersburg RRF	Dyersburg	TN	IA	100	2	MOD/SA	None
Lewisburg RRF	Lewisburg	TN	IA	60	1	MOD	WS
Nashville Thermal Transfer Corp	Nashville	TN	OP	1,050	3	MB/WW	ESP
Resource Authority in Sumner Co.	Gallatin	TN	OP	200	2	MB/RC	ESP
Center RRF	Center	TX	OP	40	1	MOD/SA	WS
City of Cleburne	Cleburne	TX	OP	115	3	MOD/SA	ESP
Panola Co. WTE	Carthage	TX	OP	40	1	MOD/SA	WS
Waxahachie Solid Waste RR	Waxahachie	TX	IA	50	2	MOD/SA	None
Davis Co. WTE	Layton	UT	OP	400	2	MB/REF	ESP DSI
Alexandria/Arlington RRF	Alexandria	VA	OP	975	3	MB/WW	ESP DSI CI(r)
Arlington - Pentagon	Arlington - Pentagon	VA	OP	50	1	MOD/SA	None
Galax City SW Steam Recovery Unit	Galax	VA	IA	56	1	MB/RC/WW	FF
Harrisonburg RRF	Harrisonburg	VA	OP	100	2	MB/WW	ESP
Henrico Co. RRF	Richmond	VA	IA	250		RDF/FB	None
I-95 Energy RRF	Lorton	VA	OP	3,000	4	MB/WW	FF SD
NASA Refuse-fired Steam Generator	Hampton	VA	OP	200	2	MB/WW	ESP
Norfolk Naval Station	Norfolk Naval Station	VA	IA	360	2	MB/WW	ESP SD(r)
Norfolk Navy Yard	Norfolk	VA	OP	2,000	4	RDF	ESP FF(r) SD(r)
Prince William and London Counties	Manassass	VA	P	1,700		MB/WW	FF SD SNCR CI
Salem Waste Disposal Energy Recovery	Salem	VA	IA	100	4	MOD/SA	None

TABLE B-2. (continued)

Unit name	Location	State	Project status	Total plant capacity, tons/d	No. of units	Combustor type	Air pollution control devices
Rutland RR Center	Rutland	VT	IA	240	2	MB/MOD	ESP WS
Fort Lewis RRF	Fort Lewis	WA	UC	120	3	MB/WW	FF SD SNCR
Recomp Bellingham RRF	Bellingham	WA	OP	100	2	MOD/SA	FF WS
Skagit Co. RRF	Mt. Vernon	WA	OP	178	2	MB/WW	FF SD
Spokane Regional Disposal Fac.	Spokane	WA	OP	800	2	MB/WW	FF SD SNCR
Tacoma	Tacoma	WA	OP	300	2	Cofired RDF/FB	FF DSI
Barron Co. WTE Fac.	Almena	WI	OP	100	2	MOD/SA	ESP
LaCrosse Co.	French Island	WI	OP	400	2	RDF/FB	DSI EGB
Madison Power Plant	Madison	WI	IA	120	2	Cofired RDF	ESP
Muscoda RRF	Muscoda	WI	IA	120	2	MOD/SA	FF DSI
Sheboygan	Sheboygan	WI	OP	216	1	MB/REF	WS
St. Croix Co. WTE Fac.	New Richmond	WI	OP	115	3	MOD/SA	FF DSI
Waukesha RRF	Waukesha	WI	IA	175	2	MB/REF	ESP
Winnebago	Winnebago	WI	P	500-1,000			None

OP = operating; IA = inactive (temporarily or permanently shutdown); UC - under construction; On hold = construction plans on hold; and P = planned.

APPENDIX C.

SELECTED INFORMATION FOR CEMENT KILNS AND LIME PLANTS

C.1 - UNITED STATES PORTLAND CEMENT KILN CAPACITIES--1995

C.2 - LIME PLANTS IN THE UNITED STATES IN 1991

TABLE C-1. PORTLAND CEMENT PRODUCTION FACILITIES--1995

Company and location	No./type of kiln	Clinker capacity,[a] 10^3 Mg/year
Alamo Cement Co.		
San Antonio, TX	1 - Dry	740
Allentown Cement Co., Inc.		
Blandon, PA	2 - Dry	844
Armstrong Cement & Sup. Co.		
Cabot, PA	2 - Wet	294
Ash Grove Cement Co.		
Nephi, UT	1 - Dry	570
Louisville, NE	2 - Dry	885
Durkee, OR	1 - Dry	422
Foreman, AR	3 - Wet	910
Montana City, MT	1 - Wet	289
Chanute, KS	2 - Wet	478
Inkom, ID	2 - Wet	205
Seattle, WA	1 - Dry	681
Blue Circle Inc.		
Ravena, NY	2 - Wet	1,596
Atlanta, GA	2 - Dry	546
Tulsa, OK	2 - Dry	544
Calera, AL	2 - Dry	578
Harleyville, SC	1 - Dry	644
Calaveras Cement Co.		
Redding, CA	1 - Dry	590
Tehachapi, CA	1 - Dry	818
California Portland Cement		
Mojave, CA	1 - Dry	1,126
Colton, CA	2 - Dry	680
Rillito, AZ	4 - Dry	1,171
Capitol Cement Corporation		
Martinsburg, WV	3 - Wet	868
Capitol Aggregates, Inc.		
San Antonio, TX	1-Dry/1-Wet	456/319
Centex		
Laramie, WY	2 - Dry	606
La Salle, IL	1 - Dry	498
Fernley, NV	2 - Dry	418
Continental Cement Co., Inc.		
Hannibal, MO	1 - Wet	544
Dacotah Cement		
Rapid City, SD	1 - Dry/2 - Wet	526/286
Dixon-Marquette		
Dixon, IL	4 - Dry	474
Dragon Products Company		
Thomaston, ME	1 - Wet	392

TABLE C-1. (continued)

Company and location	No./type of kiln	Clinker capacity,[a] 10^3 Mg/year
Essroc Materials		
Nazareth, PA	4 - Dry	530
Nazareth, PA	1 - Dry	1,067
Speed, IN	2 - Dry	921
Bessemer, PA	2 - Wet	518
Frederick, MD	2 - Wet	338
Logansport, IN	2 - Wet	412
Florida Crushed Stone		
Brooksville, FL	1 - Dry	537
Giant Cement Holding, Inc.		
Harleyville, SC	4 - Wet	788
Bath, PA	2 - Wet	546
Glens Falls Cement Co.		
Glens Falls, NY	1 - Dry	463
Hawaiian Cement Company		
Ewa Beach, HI	1 - Dry	227
Holnam, Inc.		
Midlothian, TX	1 - Dry	953
Theodore, AL	1 - Dry	1,362
Clarksville, MO	1 - Wet	1,179
Holly Hill, SC	2 - Wet	967
Mason City, IA	2 - Dry	835
Florence, CO	3 - Wet	761
Fort Collins, CO	1 - Dry	422
Dundee, MI	2 - Wet	956
Artesia, MS	1 - Wet	463
Seattle, WA	1 - Wet	404
Three Forks, MT	1 - Wet	327
Ada, OK	2 - Wet	562
Morgan, UT	2 - Wet	288
Independent Cement Corp.		
Catskill, NY	1 - Wet	544
Hagerstown, MD	1 - Dry	463
Kaiser Cement Corp.		
Permanente, CA	1 - Dry	1,451
Kosmos Cement Co.		
Kosmosdale, KY	1 - Dry	707
Pittsburgh, PA	1 - Wet	349
LaFarge Corporation		
Buffalo, IA	1 - Dry	843
Grand Chain, IL	2 - Dry	1,050
Alpena, MI	5 - Dry	2,094
Whitehall, PA	3 - Dry	791
Sugar Creek, MO	2 - Dry	478
Paulding, OH	2 - Wet	432
Fredonia, KS	2 - Wet	349

TABLE C-1. (continued)

Company and location	No./type of kiln	Clinker capacity,[a] 10^3 Mg/year
Lehigh Portland Cement		
Mason City, IA	1 - Dry	731
Leeds, AL	1 - Dry	644
Union Bridge, MD	4 - Dry	900
Mitchell, IN	3 - Dry	661
York, PA	1 - Wet	91
Waco, TX	1 - Wet	78
Lone Star Industries		
Cape Girardeau, MO	1 - Dry	1,032
Greencastle, IN	1 - Wet	616
Oglesby, IL	1 - Dry	522
Pryor, OK	3 - Dry	631
Sweetwater, TX	3 - Dry	435
Medusa Cement Co.		
Charlevoix, MI	1 - Dry	1,237
Clinchfield, GA	1-Dry/1-Wet	542/189
Wampum, PA	3 - Dry	638
Demopolis, AL	1 - Dry	735
Mitsubishi Cement Corp.		
Lucerne Valley, CA	1 - Dry	1,547
Monarch Cement Company		
Humboldt, KS	3 - Dry	611
National Cement Company of Alabama		
Ragland, AL	1 - Dry	811
Natl. Cement Co. of Califorinia		
Lebec, CA	1 - Dry	590
North Texas Cement		
Midlothian, TX	3 - Wet	768
Pennsuco Cement Co.		
Medley, FL	3 - Wet	881
Phoenix Cement Company		
Clarkdale, AZ	3 - Dry	639
RC Cement Company, Inc.		
Independence, KS	4 - Dry	292
Stockertown, PA	2 - Dry	828
Festus, MD	2 - Dry	1,102
Chattanooga, TN	2 - Wet	398
Rinker Portland Cement Corp.		
Miami, FL	2 - Wet	500
Rio Grande Cement Corp.		
Tijeras, NM	2 - Dry	432
Riverside Cement Co.		
Oro Grande, CA	7 - Dry	1,070
Riverside, CA	2 - Dry	100
RMC Lonestar		
Davenport, CA	1 - Dry	726

TABLE C-1. (continued)

Company and location	No./type of kiln	Clinker capacity,[a] 10^3 Mg/year
Roanoke Cement Company Cloverdale, VA	5 - Dry	899
Royal Cement Co. Logendale, NV	1 - Dry	177
Southdown, Inc. Victorville, CA Brooksville, FL Knoxville, TN Fairborn, OH Lyons, CO Odessa, TX	 2 - Dry 2 - Dry 1 - Dry 1 - Dry 1 - Dry 2 - Dry	 1,461 1,102 580 544 380 478
St. Mary's Peerless Cement Co. Detroit, MI	1 - Wet	590
Sunbelt Cement Corp. New Braunfels, TX	1 - Dry	880
Texas Industries New Braunfels, TX Midlothian, TX	 1 - Dry 4 - Wet	 760 1,144
Texas-Lehigh Cement Co. Buda, TX	1 - Dry	988
Total capacity reported	136 - Dry/72 - Wet	76,335

Source: U.S. and Canadian Portland Cement Industry: Plant Information Summary. December 31, 1995. Portland Cement Association, Skokie, Illinois. November, 1996.

[a]Note: All Kilns, including inactive Kilns.

Kilns reported as inactive in 1995			Clinker capacity 10^3 Mg/yr
California Portland Cement	Colton, CA	1 kiln	340
Centrex	Laramie, WY	1 kiln	211
Lafarge Corporation	Whitehall, PA	1 kiln	177
Medusa Cement Company	Clinchfield, GA	1 kiln	189
Pennsuco Corporation	Medley, FL	1 kiln	156
St. Mary’s Peerless Cement Corp.	Detroit, MI	1 kiln	590
Total active capacity			74,672

TABLE C-2. LIME PLANTS ACTIVE IN THE UNITED STATES IN 1991[a]
(Source: National Lime Association)

Company/headquarters location	Plant location/name	Type of lime produced
Alabama		
Allied Lime Company (HQ),	Alabaster	Q
Birmingham, AL	Montevallo	Q, H
Blue Circle, Inc.		
Calera, AL	Roberta	Q, H
Cheney Lime & Cement Company	Landmark	Q, H
Allgood, AL	Allgood[b]	H
Dravo Lime Company		
Saginaw, AL	Longview Div.	Q, H
Arizona		
Chemstar Lime, Inc. (HQ)	Douglas	Q
Phoenix, AZ	Nelson	Q, H
Magma Cooper Company (C)		
San Manuel, AZ	San Manuel	H
Arkansas		
Arkansas Lime Company		Q, H
Batesville, AR	Batesville	
California		
Spreckles Sugar Company, Inc. (C)		
Woodland, CA	Woodland	Q
Chemstar Lime, Inc. (HQ)	City of Industry[b]	H
Phoenix, AZ	Stockton[b]	H
Delta Sugar Corp. (C)		
Clarksburg, CA	Clarksburg	H
Holly Sugar Corp. (C)	Hamilton City	Q
Colorado Springs, CO	Brawley	Q
	Tracy	Q
Marine Magnesium Company (C)		
S. San Francisco, CA	Sonora	Q
National Refractories & Minerals Corp.		
Moss Landing, CA	Natividad	DL
Union Sugar Division of Holly Sugar Corp. (C)		
Santa Maria, CA	Betteravia	Q
Colorado		
Calco, Inc.		
Salida, CO	Salida	Q
Western Sugar Company		
Fort Morgan, CO	Fort Morgan	Q
Greeley, CO	Greeley	Q
Idaho		
The Amalgamated Sugar Company (C)		
Nampa, ID	Nampa	Q
Paul, ID	Mini-Cassia	Q
Twin Falls, ID	Twin Falls	Q
Phoenix, AZ	Ten Mile[c]	Q

TABLE C-2. (continued)

Company/headquarters location	Plant location/name	Type of lime produced
Illinois		
Marblehead Lime Company (HQ)	South Chicago	Q, H
Chicago, IL	Thornton	DL, DH, DB
	Buffington	Q
Vulcan Materials Company	McCook	DL
Countryside, IL		
Inland Steel Company (C)	Indiana Harbor	Q
E. Chicago, IN		
Iowa		
Linwood Mining & Minerals Corp.	Linwood (UG)	Q, H
Davenport, IA		
Kentucky		
Dravo Lime Company (HQ)	Black River Div. (UG)	Q, H
Pittsburgh, PA	Maysville Div. (HG)	Q
Louisiana		
Dravo Lime Company (HQ)		
Pittsburgh, PA	Pelican[b]	H
USG Corp. (HQ)		
Chicago, IL	New Orleans	Q, H
Massachusetts		
Lee Lime Corp.		
Lee, MA	Lee	DL, DH
Pfizer, Inc.		
Adams, MA	Adams	Q
Michigan		
Detroit Lime Company	River Rouge	Q
Detroit, MI		
The Dow Chemical Company (C)	Ludington	DL
Ludington, MI		
Marblehead Lime Company (HQ)	River Rouge	Q
Chicago, IL	Brennan	Q, H
Michigan Sugar Company (C)	Sebawaing	Q
Saginaw, MI	Carollton	Q
	Crosswell	Q
	Caro	Q
Monitor Sugar Company (C)	Bay City	Q
Bay City, MI		
Minnesota		
American Crystal Sugar Company (C)	Moorhead	Q
Moorhead, MN	Crookston	Q
	East Grand Forks	Q
Southern Minn. Sugar Corp. (C)		Q
Renville, MN	Renville	

TABLE C-2. (continued)

Company/headquarters location	Plant location/name	Type of lime produced
Missouri		
Ash Grove Cement Company		
Springfield, MO	Springfield	Q, H
Mississippi Lime Company (HQ)		
Alton, IL	Ste. Genevieve (UG)	Q, H
Resco Products of Missouri, Inc. (HQ)		
Clearfield, PA	Bonne Terre	DL, Q, DB
Montana		
Continental Lime, Inc.	Indian Creek	Q
Townsend, MT		
Holly Sugar Corp. (C)	Sidney	Q
Colorado Springs, CO		
Western Sugar Company	Billings	Q
Billings, MT		
Nebraska		
Western Sugar Company (C)		
Bayard, NE	Bayard	Q
Mitchell, NE	Mitchell	Q
Scottsbluff, NE	Scottsbluff	Q
Nevada		
Chemstar Lime, Inc. (HQ)	Apex	Q, H
Phoenix, AZ	Henderson	DL, DH
Continental Lime, Inc.		
Wendover, NV	Pilot Peak	Q
North Dakota		
American Crystal Sugar Company (C)		
Drayton, ND	Drayton	Q
Hillsboro, ND	Hillsboro	Q
Minn-Dak Farmers Corp. (C)		
Wahpeton, ND	Minn-Dak	Q
Ohio		
Elkem Metals Company (C)		
Astabula, OH	Ashtabula	Q
GenLime Group LP		
Genoa, OH	Genoa	DL, DH
The Great Lakes Sugar Company (C)		
Fremont, OH	Fremont	Q
Huron Lime Company		
Huron, OH	Huron	Q
LTV Steel (C&S)		
Grand River, OH	Grand River	Q
Martin Marietta (C&S)		
Woodville, OH	Woodville	DL, DB
National Lime & Stone Company		
Findlay, OH	Carey	DL, DH
Ohio Lime Company	Woodville	DL
Woodville, OH	Millersville	DL

TABLE C-2. (continued)

Company/headquarters location	Plant location/name	Type of lime produced
Oklahoma		
St. Clair Lime Company Oklahoma City, OK	Marble City (UG)	Q, H
Oregon		
The Amalgamated Sugar Company (C) Nyssa, OR	Nyssa	Q
Ash Grove Cement Company Portland, OR	Portland	Q, H
Pennsylvania		
J.E. Baker Company (C&S) York, PA	York	DB
Bellefonte Lime Company Bellefonte, PA	Bellefonte	Q, H
Centre Lime & Stone Company Pleasant Gap, PA	Pleasant Gap	Q, H
Con Lime Company Bellefonte, PA	Bellefonte (UG)	Q, H
Corson Lime Company Plymouth Meeting, PA	Plymouth Meeting	DL, DH
Mercer Lime & Stone Company Pittsburgh, PA	Branchton	Q, H
Warner Company Devault, PA	Cedar Hollow	DL, DH
Wimpey Minerals PA, Inc. Annville, PA	Hanover Annville	DL, Q Q, H
Puerto Rico		
Puerto Rican Cement Company, Inc. Ponce, PR	Ponce	Q, H
South Dakota		
Pete Lien & Sons, Inc. Rapid City, SD	Rapid City	Q, H
Tennessee		
Bowater Southern Paper Corp. (C) Calhoun, TN	Calhoun	Q
Tenn Luttrell Company Luttrell, TN	Luttrell (UG)	Q, H

TABLE C-2. (continued)

Company/headquarters location	Plant location/name	Type of lime produced
Texas		
APG Lime Corp.		
New Braunfels, TX	New Braunfels	Q, H, DL, DH
Austin White Lime Company		
Austin, TX	McNeil	Q, H
Chemical Lime, Inc.	Clifton	Q, H
Clifton, TX	Marble Falls	DL
Holly Sugar Corp. (C)		
Colorado Springs, CO	Hereford	Q
Redland Stone Products Company		
San Antonio, TX	San Antonio	Q, H
Texas Lime Company	No. 1	Q, H
Cleburne, TX	Round Rock[d]	Q, H
Utah		
Chemstar Lime, Inc. (HQ)		
Phoenix, AZ	Dolomite	DL, DH
Continental Lime, Inc.		
Delta, UT	Cricket Mountain	Q
M.E.R.R. Corp.		
Grantsville, UT	Marblehead Mt.[e]	DL
Virginia		
APG Lime Corp		
Ripplemead, VA	Kimballton (UG)	Q, H
Chemstone Corp.		
Strasburg, VA	Dominion	Q, H
W.S. Frey Company, Inc.		
York, PA	Clearbrook	Q
Riverton Corp. (C)		
Riverton, VA	Riverton	H
Shenvalley Lime Corp.		
Stephens City, VA	Stephens City[b]	H
Virginia Lime Company		
Ripplemead, VA	Kimballton (UG)	Q, H
Washington		
Northwest Alloys, Inc. (C)		
Addy, WA	Addy	DL
Continental Lime, Inc.		
Tacoma, WA	Tacoma	Q, H
West Virginia		
Germany Valley Limestone Company		
Riverton, WV	Riverton	Q, H
Wisconsin		
CLM Corp. (HQ)		
Duluth, MN	Superior	Q, H
Rockwell Lime Company		
Manitowoc, WI	Manitowoc	DL, DH
Western Lime & Cement Company	Green Bay	Q, H
West Bend, WI	Eden	DL, DH

TABLE C-2. (continued)

Company/headquarters location	Plant location/name	Type of lime produced
Wyoming		
Holly Sugar Company (C)	Torrington	Q
Colorado Springs, CO	Worland	Q
The Western Sugar Company (C)		
Lovell, WY	Lowell	Q

KEY:

C = Lime plant is operated predominantly for captive consumption.
C&S = Captive and sales--captive consumption with significant commercial sales.
DB = Refractory, dead-burned dolomite.
DH = Dolomitic hydrate.
DL = Dolomitic quicklime.
H = Hydrated lime.
HQ = Headquarters address.
Q = Quicklime.
UG = Underground mine.

[a]Excludes regenerated lime.

[b]Hydrating plant only.

[c]New plant, scheduled to come on-line August 1992.

[d]Plant did not operate in 1991; it has been mothballed.

[e]Closed December 1991, last shipments made May 1992.

APPENDIX D.

CRUDE OIL DISTILLATION CAPACITY

Table 5. Refiners' Operable Atmospheric Crude Oil Distillation Capacity as of January 1, 1995

Refiner	Barrels per Calendar Day
Companies with Capacity Over 100,000 bbl/cd	
Chevron U.S.A. Inc.	1,206,000
Pascagoula, Mississippi	295,000
El Segundo, California	230,000
Richmond, California	230,000
Port Arthur, Texas	185,000
El Paso, Texas	87,000
Perth Amboy, New Jersey	80,000
Honolulu, Hawaii	54,000
Salt Lake City, Utah	45,000
Amoco Oil Co.	998,000
Texas City, Texas	433,000
Whiting, Indiana	410,000
Mandan, North Dakota	58,000
Yorktown, Virginia	53,000
Salt Lake City, Utah	44,000
Exxon Co. U.S.A.	992,000
Baton Rouge, Louisiana	424,000
Baytown, Texas	396,000
Benicia, California	128,000
Billings, Montana	44,000
Mobil Oil Corp.	929,000
Beaumont, Texas	315,000
Joliet, Illinois	188,000
Chalmette, Louisiana	170,000
Torrance, California	130,000
Paulsboro, New Jersey	126,000
Shell Oil Co.	761,000
Wood River, Illinois	268,000
Norco, Louisiana	215,000
Martinez, California	148,900
Anacortes, Washington	100,500
Odessa, Texas	28,600
BP America Inc.	700,500
BP Oil Corp.	
Belle Chasse (Alliance), Louisiana	231,500
Marcus Hook, Pennsylvania	172,000
Lima, Ohio	161,000
Toledo, Ohio	136,000
Sun Co Inc.	700,000
Marcus Hook, Pennsylvania	175,000
Toledo, Ohio	125,000
Tulsa, Oklahoma	85,000
Sun Refining & Marketing	
Philadelphia, Pennsylvania	315,000
Star Enterprise	600,000
Port Arthur/Neches, Texas	235,000
Convent, Louisiana	225,000
Delaware City, Delaware	140,000
USX Corp.	570,000
Marathon Oil Co.	
Garyville, Louisiana	255,000
Robinson, Illinois	175,000
Detroit, Michigan	70,000
Texas City, Texas	70,000
Petroleos De Venezuela	503,000
Citgo Petroleum Corp.	
Lake Charles, Louisiana	305,000
Citgo Refining & Chemical Inc.	
Corpus Christi, Texas	130,000
Citgo Asphalt Refining Co.	
Paulsboro, New Jersey	40,000
Savannah, Georgia	28,000
Koch Industries Inc.	485,000
Koch Refining Co.	
Corpus Christi, Texas	255,000
St. Paul (Pine Bend), Minnesota	230,000
Tosco Corp.	470,000
Bayway Refining Co.	
Bayway, New Jersey	215,000
Tosco Refining Co.	
Martinez (Avon), California	160,000
Tosco Northwest Co.	
Ferndale, Washington	95,000
Atlantic Richfield Co.	453,000
Arco Products Co.	
Los Angeles, California	237,000
Ferndale (Cherry Point), Washington	189,000
Arco Alaska Inc.	
Prudhoe Bay, Alaska	15,000
Kuparuk, Alaska	12,000
E I Du Pont De Nemours & Co.	438,000
Conoco Inc.	
Westlake, Louisiana	191,000
Ponca City, Oklahoma	140,000
Commerce City, Colorado	57,500
Billings, Montana	49,500
Texaco Refining & Marketing Inc.	350,600
Anacortes (Puget Sound), Washington	136,000
El Dorado, Kansas	94,600
Wilmington (Los Angeles), California	64,000
Bakersfield, California	56,000
Ashland Oil Inc.	346,500
Catlettsburg, Kentucky	213,400
St. Paul, Minnesota	67,100
Canton, Ohio	66,000
Phillips Petroleum Co.	320,000
Phillips 66 Co.	
Sweeny, Texas	185,000
Borger, Texas	110,000
Woods Cross, Utah	25,000
Lyondell Petrochemical Co.	
Lyondell Citgo Refining Co. Ltd.	
Houston, Texas	265,000

See footnotes at end of table.

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Table 5. Refiners' Operable Atmospheric Crude Oil Distillation Capacity as of January 1, 1995 (Continued)

Refiner	Barrels per Calendar Day
Solomon Inc.	254,500
Phibro Energy U.S.A. Inc.	
Texas City, Texas	123,500
Houston, Texas	71,000
Krotz Springs, Louisiana	60,000
Coastal Corp., The	236,500
Coastal Eagle Point Oil Co.	
Westville, New Jersey	125,000
Coastal Refining & Marketing Inc.	
Corpus Christi, Texas	95,000
Coastal Mobile Refining Co.	
Chickasaw, Alabama	16,500
Fina Oil & Chemical Co.	230,000
Port Arthur, Texas	175,000
Big Spring, Texas	55,000
Unocal Corp.	220,700
Wilmington (Los Angeles), California	105,600
Rodeo (San Francisco), California	73,100
Arroyo Grande (Santa Maria), California	42,000
Mapco Petroleum Inc.	217,200
North Pole, Alaska	128,200
Memphis, Tennessee	89,000
Shell Oil/PMI Holdings North America	
Deer Park Refg Ltd Partnership	
Deer Park, Texas	215,900
Diamond Shamrock Refining & Marketing Co.	207,000
Sunray (McKee), Texas	132,000
Three Rivers, Texas	75,000
Total Petroleum Inc.	197,600
Ardmore, Oklahoma	68,000
Arkansas City, Kansas	56,000
Alma, Michigan	45,600
Colorado Refining Co.	
Commerce City, Colorado	28,000
Crown Central Petroleum Corp.	155,000
Pasadena, Texas	100,000
La Gloria Oil & Gas Co.	
Tyler, Texas	55,000
Kerr-McGee Corp.	154,800
Southwestern Refining Co. Inc.	
Corpus Christi, Texas	104,000
Kerr-McGee Refining Corp.	
Wynnewood, Oklahoma	43,000
Cotton Valley, Louisiana	7,800
Uno-Ven Co.	
Lemont (Chicago), Illinois	147,000
Horsham Corp	143,015
Clark Refining & Marketing	
Blue Island, Illinois	80,515
Hartford, Illinois	62,500
Murphy Oil U.S.A. Inc.	133,200
Meraux, Louisiana	100,000
Superior, Wisconsin	33,200
Sinclair Oil Corp	132,500
Tulsa, Oklahoma	54,000
Sinclair, Wyoming	54,000
Little America Refining Co.	
Evansville (Casper), Wyoming	24,500
Castle Energy Corp.	127,250
Indian Refining	
Lawrenceville, Illinois	80,750
Powerine Oil Co.	
Santa Fe Springs, California	46,500
Cenex	117,050
National Cooperative Refinery Assoc.	
McPherson, Kansas	75,600
Cenex	
Laurel, Montana	41,450
Total	**13,976,815**
Companies with Capacity 30,001 to 100,000 bbl/cd	
BHP Petroleum Americas Refining Inc.	
Ewa Beach, Hawaii	93,500
Tesoro Petroleum Corp.	
Kenai, Alaska	72,000
LL&E Petroleum Marketing, Inc.	
Saraland (Mobile), Alabama	71,000
Farmland Industries Inc.	
Coffeyville, Kansas	68,600
American Ultramar Ltd	
Ultramar Refg	
Wilmington, California	68,000
Holly Corp.	64,000
Navajo Refining Co.	
Artesia, New Mexico	57,000
Montana Refining Co.	
Great Falls, Montana	7,000
Pennzoil Co. Inc.	61,900
Pennzoil Producing Co.	
Shreveport, Louisiana	46,200
Rouseville, Pennsylvania	15,700
United Refining Co.	
Warren, Pennsylvania	60,000
Lion Oil Co.	
El Dorado, Arkansas	51,000

See footnotes at end of table.

Table 5. Refiners' Operable Atmospheric Crude Oil Distillation Capacity as of January 1, 1995 (Continued)

Refiner	Barrels per Calendar Day
The Coastal Corp/Sinochem	
Pacific Refining Co.	
Hercules, California	50,000
Placid Refining Co.	
Port Allen, Louisiana	48,500
Paramount Acquisition Corp.	
Paramount Petroleum Corp.	
Paramount, California	46,500
Pride Refining Inc.	
Abilene, Texas	42,750
Enjet	
St. Rose Refining Inc.	
St. Rose, Louisiana	40,000
Frontier Refining Co.	
Cheyenne, Wyoming	38,670
Petro Star Inc.	36,300
Valdez, Alaska	26,300
North Pole, Alaska	10,000
Hunt Consolidated Inc.	
Hunt Refining Co.	
Tuscaloosa, Alabama	33,500
Time Oil Co.	
U.S. Oil & Refining Co.	
Tacoma, Washington	32,400
Total	**978,620**
Companies with Capacity 10,001 to 30,000 bbl/cd	
Valero Refining Co.	
Corpus Christi, Texas	29,900
Gold Line Refining Ltd.	
Lake Charles, Louisiana	27,600
Neste Trifinery Petro Serve [a]	
Corpus Christi, Texas	27,000
Crysen Corp.	24,400
Crysen Refining Inc.	
Woods Cross, Utah	12,500
Sound Refining Inc.	
Tacoma, Washington	11,900
San Joaquin Refining Co. Inc.	
Bakersfield, California	24,300
Flying J Petroleum Inc.	
Big West Oil Co.	
North Salt Lake, Utah	24,000
Ergon Inc.	
Vicksburg, Mississippi	23,000
Countrymark Cooperative Inc.	
Mount Vernon, Indiana	22,000
Kern Oil & Refining Co.	
Bakersfield, California	21,400
Giant Industries Inc.	
Giant Refining Co.	
Gallup, New Mexico	20,800
World Oil Co.	20,100
Sunland Refining Corp.	
Bakersfield, California	12,000
Lunday Thagard	
South Gate, California	8,100
Barrett Refining Corp.	18,500
Thomas (Custer), Oklahoma	10,500
Vicksburg, Mississippi	8,000
VGS Corp.	16,800
Southland Oil Co.	
Sandersville, Mississippi	11,000
Lumberton, Mississippi	5,800
Gary Williams Co.	
Bloomfield Refining Co.	
Bloomfield, New Mexico	16,800
Huntway Refining Co.	14,100
Benicia, California	8,600
Wilmington, California	5,500
Wyoming Refining Co.	
Newcastle, Wyoming	12,555
Transworld Oil U.S.A. Inc.	
Calcasieu Refining Co.	
Lake Charles, Louisiana	12,500
Quaker State Corp.	
Newell (Congo), West Virginia	11,500
Asphalt Materials	
Laketon Refining Corp.	
Laketon, Indiana	11,100
Apex Oil Co., Inc.	
Petroleum Fuel & Terminal	
Long Beach, California	10,800
Total	**389,155**
Companies with Capacity 10,000 bbl/cd or Less	
Witco Corp.	
Bradford, Pennsylvania	10,000
Anchor Gasoline Corp.	
Canal Refining Co.	
Church Point, Louisiana	9,500

See footnotes at end of table.

Table 5. Refiners' Operable Atmospheric Crude Oil Distillation Capacity as of January 1, 1995 (Continued)

Refiner	Barrels per Calendar Day	Refiner	Barrels per Calendar Day
Calumet Lubricants Co. L.P. Princeton, Louisiana	8,200	Young Refining Corp. Douglasville, Georgia	5,540
Cayman Resources Cyril Petrochemical Corp. Cyril, Oklahoma	7,500	Somerset Refinery Inc. Somerset, Kentucky	5,500
Arcadia Refining [b] Lisbon, Louisiana	7,350	Oil Holdings Inc. Tenby Inc. Oxnard, California	4,000
Bechtel Investment Inc. Petro Source Refining Partners Eagle Springs, Nevada	7,000	Unico, Inc. Intermountain Refining Co., Inc. Fredonia, Arizona	3,800
Martin Gas Sales Inc. Berry Petroleum Co. Stephens, Arkansas	6,700	Howell Corp. Howell Hydrocarbons & Chemical Inc. Channelview, Texas	1,400
Cross Oil & Refining Co. Inc. Smackover, Arkansas	6,200	Petrolite Corp. Kilgore, Texas	1,000
Age Refining & Marketing San Antonio, Texas	6,000	**Total**	**89,690**
		U.S. Total	**15,434,280**

Source: United States Refining Capacity, January 1, 1995
National Petroleum Refiners Association, Washington, DC

[a]Formerly Petroserve Ltd. (Trifinery)
[b]Formerly Dubach Gas Co.
bbl/cd = Barrels per Calendar Day.
Source: Energy Information Administration (EIA), Form EIA-820, "Annual Refinery Report."

APPENDIX E.

PULP AND PAPER MILLS IN THE UNITED STATES IN 1994

TABLE E-1. PULP AND PAPER MILLS IN THE UNITED STATES IN 1994

Mill name	Location	Type of pulping process
Alabama Pine Pulp	Perdue Hill, AL	Kraft
Alabama River Pulp	Perdue Hill, AL	Kraft
Appleton Papers, Inc.	Roaring Springs, PA	Kraft
Arkansas Kraft	Oppelo, LA	Kraft
Badger Paper Mills, Inc.	Peshtigo, WI	Sulfite
Boise Cascade Corp.	Deridder, LA	Kraft
Boise Cascade Corp.	International Falls, MN	Kraft
Boise Cascade Corp.	Jackson, AL	Kraft
Boise Cascade Corp.	Rumford, ME	Kraft
Boise Cascade Corp.	St. Helens, OR	Kraft
Boise Cascade Corp.	Wallula, WA	Kraft
Bowater Inc. Carolina Division	Catawba, SC	Kraft
Bowaters	Calhoun, TN	Kraft
Champion International	Canton, NC	Kraft
Champion International	Courtland, AL	Kraft
Champion International	Lufkin, TX	Kraft
Champion International	Quinnesec, MI	Kraft
Champion International	Roanoke Rapids, NC	Kraft
Champion International	Sheldon, TX	Kraft
Champion International	Cantonment, FL	Kraft
Chesapeake Paper Products Co.	West Point, VA	Kraft
Consolidated Packaging Corp.	Fort Madison, IA	Semichemical
Consolidated Papers	Wisconsin Rapids, WI	Kraft
Container Corp. of America	Fernandina Beach, FL	Kraft
Cross-Pointe Paper Co.	Park Falls, WI	Sulfite
Federal Paper Board Co.	Augusta, GA	Kraft
Federal Paper Board, Inc.	Riegelwood, NC	Kraft
Finch, Pruyn, & Co., Inc.	Glens Falls, NY	Sulfite
Gaylord Container Corp.	Bogalusa, LA	Kraft
Gaylord Container Corp.	Pine Bluff, AR	Kraft
Georgia-Pacific Corp.	Ashdown, AR	Kraft
Georgia-Pacific Corp.	Bellingham, WA	Sulfite
Georgia-Pacific Corp.	Big Island, VA	Semichemical
Georgia-Pacific Corp.	Brunswick, GA	Kraft
Georgia-Pacific Corp.	Cedar Springs, GA	Kraft
Georgia-Pacific Corp.	Crossett, AR	Kraft
Georgia-Pacific Corp.	Monticello, MS	Kraft
Georgia-Pacific Corp.	Nekoosa, WI	Kraft
Georgia-Pacific Corp.	New Augusta, MS	Kraft
Georgia-Pacific Corp.	Palatka, FL	Kraft
Georgia-Pacific Corp.--Nekoosa Paper Co.	Port Edwards, WI	Sulfite
Georgia-Pacific Corp.	Toledo, OR	Kraft

TABLE E-1. (continued)

Mill name	Location	Type of pulping process
Georgia-Pacific Corp.	Woodland, ME	Kraft
Georgia-Pacific Corp.	Zachary, LA	Kraft
Gilman Paper Co.	St. Mary's, GA	Kraft
Great Northern Paper Co.	Millinocket, ME	Sulfite
Groveton Paper	Groveton, NH	Semichemical
Gulf States Paper Corp.	Demopolis, AL	Kraft
ITT Rayonier, Inc.	Fernandina Beach, FL	Sulfite
ITT-Rayonier, Inc.	Jesup, GA	Kraft
ITT Rayonier, Inc.	Port Angeles, WA	Sulfite
Inland Container Corp.	New Johnsonville, TN	Semichemical
Inland-Orange, Inc.	Orange, TX	Kraft
Inland-Rome, Inc.	Rome, GA	Kraft
International Paper	Bastrop, LA	Kraft
International Paper	Camden, AR	Kraft
International Paper	Erie, PA	Soda
International Paper	Gardiner, OR	Kraft
International Paper	Georgetown, SC	Kraft
International Paper	Jay, ME	Kraft
International Paper	Mansfield, LA	Kraft
International Paper	Mobile, AL	Kraft
International Paper	Moss Point, MS	Kraft
International Paper	Natchez, MS	Kraft
International Paper	Pine Bluff, AR	Kraft
International Paper	Pineville, LA	Kraft
International Paper	Selma, AL	Kraft
International Paper	Texarkana, TX	Kraft
International Paper	Ticonderoga, NY	Kraft
International Paper	Vicksburg, MS	Kraft
Interstate Paper	Riceboro, GA	Kraft
JSC/Container	Brewton, AL	Kraft
JSC/Container	Jacksonville, FL	Kraft
James River Corp.	Berlin, NH	Kraft
James River Corp.	Camas, WA	Kraft
James River Corp.	Camas, WA	Sulfite
James River Corp.	Clatskanie, OR	Kraft
James River Corp.	Pennington, AL	Kraft
James River Corp.	St. Francisville, LA	Kraft
James River Paper Co.	Old Town, ME	Kraft
Jefferson Smurfit	Circleville, OH	Semichemical
Ketchikan Pulp Co.	Ketchikan, AK	Sulfite
Kimberly-Clark Corp.	Coosa Pines, AL	Kraft

TABLE E-1. (continued)

Mill name	Location	Type of pulping process
Lincoln Pulp & Paper	Lincoln, ME	Kraft
Longview Fibre Co.	Longview, WA	Kraft
Louisiana Pacific	Samoa, CA	Kraft
MacMillan Bloedel, Inc.	Pine Hill, AL	Kraft
Mead Coated Board	Phenix City, AL	Kraft
Mead Corp.	Kingsport, TN	Soda
Mead Corp.	Stevenson, AL	Semichemical
Mead Paper	Escanaba, MI	Kraft
Mead Paper/Chillicothe Division	Chillicothe, OH	Kraft
Menasha Corp.	Otsego, MI	Semichemical
Mosinee Paper	Mosinee, WI	Kraft
P.H. Glatfelter	Spring Grove, PA	Kraft
Packaging Corp. of America	Counce, TN	Kraft
Packaging Corp. of America	Filer City, MI	Semichemical
Packaging Corp. of America	Tomahawk, WI	Semichemical
Packaging Corp. of America	Valdosta, GA	Kraft
Pope & Talbot	Halsey, OR	Kraft
Port Townsend Paper Corp.	Port Townsend, WA	Kraft
Potlatch Corp.	Cloquet, MS	Kraft
Potlatch Corp.	Lewiston, ID	Kraft
Potlatch Corp.	McGehee, AR	Kraft
Procter & Gamble	Mehoopany, PA	Sulfite
Procter & Gamble Cellulose	Ogelthorpe, GA	Kraft
Procter & Gamble Cellulose	Perry, FL	Kraft
Riverwood International Georgia	Macon, GA	Kraft
Riverwood International	West Monroe, LA	Kraft
S.D. Warren Co.	Muskegon, MI	Kraft
S.D. Warren Co.	Westbrook, ME	Kraft
Scott Paper Co.	Everett, WA	Sulfite
Scott Paper Co.	Mobile, AL	Kraft
Scott Paper Co.	Skohegan, ME	Kraft
Simpson Paper	Pasadena, TX	Kraft
Simpson Paper	Tacoma, WA	Kraft
Sonoco Products	Hartsville, SC	Semichemical
St. Joe Forest Products	Port St. Joe, FL	Kraft
Stone Container Corp.	Coshocton, OH	Semichemical
Stone Container Corp.	Florence, SC	Kraft
Stone Container Corp.	Hodge, LA	Kraft
Stone Container Corp.	Missoula, MT	Kraft
Stone Container Corp.	Ontonagon, MI	Semichemical
Stone Container Corp.	Panama City, FL	Kraft

TABLE E-1. (continued)

Mill name	Location	Type of pulping process
Stone Container Corp.	Snowflake, AZ	Kraft
Stone Hopewell, Inc.	Hopewell, VA	Kraft
Stone Savannah River	Port Wentworth, GA	Kraft
Temple-Inland Forest Products	Evadale, TX	Kraft
Thilmany International	Kaukauna, WI	Kraft
Union Camp Corp.	Eastover, SC	Kraft
Union Camp Corp.	Franklin, VA	Kraft
Union Camp Corp.	Prattville, AL	Kraft
Union Camp Corp.	Savannah, GA	Kraft
Virginia Fibre Corp.	Amherst/Riverville, VA	Semichemical
Wausau Paper Mills Co.	Brokaw, WI	Sulfite
Weston Paper & Manufacturing Corp.	Terra Haute, IN	Semichemical
Westvaco Corp.	Covington, VA	Kraft
Westvaco Corp.	Luke, MD	Kraft
Westvaco Corp.	N. Charleston, SC	Kraft
Westvaco Corp.	Wickliffe, KY	Kraft
Weyerhaeuser Paper Co.	Columbus, MS	Kraft
Weyerhaeuser Paper Co.	Cosmopolis, WA	Sulfite
Weyerhaeuser Paper Co.	Longview, WA	Kraft
Weyerhaeuser Paper Co.	New Bern, NC	Kraft
Weyerhaeuser Paper Co.	Plymouth, NC	Kraft
Weyerhaeuser Paper Co.	Rothschild, WI	Sulfite
Weyerhaeuser Paper Co.	Springfield, OR	Kraft
Weyerhaeuser Paper Co.	Valliant, OK	Kraft
Williamette Industries, Inc.	Albany, OR	Kraft
Williamette Industries, Inc.	Bennettsville, SC	Kraft
Williamette Industries, Inc.	Campti, LA	Kraft
Williamette Industries, Inc.	Hawesville, KY	Kraft
Williamette Industries, Inc.	Johnsonburg, PA	Kraft

Sources: Midwest Research Institute (MRI), 1996. Memorandum from Nicholson, R., MRI, to Telander, J., EPA/MICG. June 13, 1996. Addendum to Summary of Responses to the 1992 NCASI "MACT" Survey.

Midwest Research Institute (MRI), 1995. Memorandum from Soltis, V., MRI to the project file. April 24,1995. U.S. Population of Sulfite and Stand-Alone Semichemical Pulp Mills.

APPENDIX F.

EMISSION FACTORS BY SOURCE CLASSIFICATION CODE

TABLE F-1. SUMMARY OF EMISSION FACTORS BY SOURCE CLASSIFICATION CODE

SCC/ Description	Emissions Source	Control Device(s)	Emission Factor[a]		Factor Rating
			Range	Average	
3-13-020-00 Mercury Oxide Battery Manufacture	Overall Process	Uncontrolled	---	2[b]	U
3-13-005-00 Electrical Switch Manufacture	Overall Process	Uncontrolled	---	8[b]	U
3-13-011-00 Fluorescent Lamp Manufacture	Overall Process	Uncontrolled	---	8[b]	U
3-13-012-00 Fluorescent Lamp Recycling	Lamp Crusher	Fabric Filter and Carbon Adsorber	---	1.9 E-09[c]	E
3-15-027-00 Thermometer Manufacture	Overall Process	Uncontrolled	---	18[b]	U
1-01-002, 1-02-002, 1-03-002 Bituminous and Subbituminous Coal Combustion	Industrial Boilers; Commercial and Residential Boilers	Uncontrolled	---	16[d]	E
1-01-001, 1-02-001, 1-03-001 Anthracite Coal Combustion	Industrial Boilers; Commercial and Residential Boilers	Uncontrolled	---	18[d]	E
1-01-004 No. 6 Oil Fired	Utility Boilers; Industrial Boilers; Commercial and Residential Boilers	Uncontrolled	---	0.46[d]	E

TABLE F-1. (continued)

SCC/ Description	Emissions Source	Control Device(s)	Emission Factor[a] Range	Emission Factor[a] Average	Factor Rating
1-01-005 Distillate Oil Fired	Utility Boilers; Industrial Boilers; Commercial and Residential Boilers	Uncontrolled	---	6.2[d]	E
1-01-009, 1-02-009, 1-03-009 Wood Waste Combustion	Industrial Boilers	Uncontrolled	---	2.6 E-06[e]	E
5-01-005-15 Sewage Sludge Incinerators	Multiple Hearth Incinerators	Venturi Scrubber Cyclone	--- ---	3.5 E-05[f] 3.2 E-03[f]	E E
3-05-006, 3-05-007 Portland Cement Manufacture	Kiln Stack	Fabric Filter; ESP; Venturi Scrubber	---	1.3 E-04[g]	E
3-05-016-18 Lime Manufacture	Coal-Fired Rotary Kiln Stack	Cyclone and Fabric Filter	7.6 E-06 - 1.8 E-05	1.5 E-05[h]	E
3-05-016-19 Lime Manufacture	Gas-Fired Vertical Kiln Stack	Fabric Filter	---	3.0 E-06[h]	E
3-01-005-04 Carbon Black Manufacturing	Main Process Vent	Fabric Filter	---	3 E-04[j]	U
3-03-003 Coke Production	Overall Process	Fabric Filter; ESP	---	6 E-05[k]	U
1-01-015-01 1-01-015-02 Geothermal Power Plants	Off-Gas Ejectors Cooling Tower Exhaust	Uncontrolled Uncontrolled	--- ---	2 E-05[m] 1 E-04[m]	U U

TABLE F-1. (continued)

SCC/ Description	Emissions Source	Control Device(s)	Emission Factor[a] Range	Emission Factor[a] Average	Factor Rating
3-07-001-04 3-07-001-10 Chemical Wood Pulping	Kraft/Soda Recovery Furnace	ESP; Wet Scrubber	---	3.9 E-05[n]	U
3-07-001-05	Kraft/Soda SDTs	Venturi Scrubber; Wet Scrubber	---	5.23 E-08[n]	U
3-07-001-06	Kraft/Soda Lime Kiln	Wet Scrubber; ESP	---	2.91 E-06[h]	U
3-15-025-00 Dental Alloy (Mercury Amalgam) Production	Overall Process	Uncontrolled	---	40[b]	U
3-15-021-01 Crematoriums	Crematory Stack	Uncontrolled	---	3.3 E-03[p]	E

[a]To convert from lb/ton to kg/Mg, multiply by 0.5.
[b]lb/ton of mercury used.
[c]lb/lamp crushed.
[d]lb/10^{12} Btu.
[e]lb/ton of dry wood fuel.
[f]lb/ton of sludge processed.
[g]lb/ton of clinker produced.
[h]lb/ton of lime produced.
[j]lb/ton of carbon black produced.
[k]lb/ton of coke produced.
[m]lb/MWe/hr.
[n]lb/ton of black liquor solid fuel.
[p]lb/body burned.

TECHNICAL REPORT DATA

(PLEASE READ INSTRUCTIONS ON THE REVERSE BEFORE COMPLETING)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Locating And Estimating Air Emissions From Sources Of Mercury And Mercury Compounds EPA-454/R-97-012)		5. REPORT DATE 12/1/97 6. PERFORMING ORGANIZATION CODE
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15. SUPPLEMENTARY NOTES

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16. ABSTRACT

To assist groups interested in inventorying air emissions of various potentially toxic substances, the U.S. Environmental Protection Agency is preparing a series of documents such as this to compile available information on sources and emissions of these substances. This document deals specifically with mercury and mercury compounds. Its intended audience includes Federal, State and local air pollution personnel and others interested in locating potential emitters of mercury and mercury compounds and in making gross estimates of air emissions therefrom.

This document presents information on (1) the types of sources that may emit mercury and mercury compounds, (2) process variations and release points for these sources, and (3) available emissions information indicating the potential for mercury and mercury compound releases into the air from each operation.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI FIELD/GROUP
MERCURY, MERCURY COMPOUNDS AIR EMISSION SOURCES TOXIC SUBSTANCES EMISSION ESTIMATION		
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